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Bothalia is named in honour of General Louis Botha, first Premier and Minister of Agriculture of the Union of South Africa. This house journal of the Botanical Research Institute is devoted to the furtherance of botanical science. The main fields covered are taxonomy, ecology, anatomy and cytology. One or two parts of the journal and an index to contents, authors and subjects are published annually.

Bothalia is vernoem ter ere van Generaal Louis Botha, eerste Eerste Minister en Minister van Landbou van die Unie van Suid-Afrika. Hierdie lyfblad van die Navorsingsinstituut vir Plantkunde is gewy aan die bevordering van die wetenskap van plantkunde. Die hoofgebiede wat gedek word, is taksonomie, ekologie, anatomie en sitologie. Een of twee dele van die tydskrif en 'n indeks van die inhoud, outeurs en onderwerpe verskyn jaarliks.

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Two parts of ten plates each are published annually. A volume consists of four parts. The publication is available in English and Afrikaans.

Hierdie reeks bied kleurplate van Afrikaanse plante met bygaande teks. Die skilderye word meestal deur die kunstenaars van die Navorsingsinstituut vir Plantkunde voorberei. Talle bekende botaniese kunstenaars het tot die reeks bygedra, soos Cythna Letty (meer as 700 plate), Kathleen Lansdell, Stella Gower, Betty Connell, Peter Bally en Fay Anderson. Die Redakteur verwelkom lewende plante van algemene belang of ekonomiese waarde vir afbeelding.

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BOTHALIA

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CONTENTS - INHOUD

Volume 17,2

Bothalia 17,2: 163–170 (1987)

Studies in the Ericoideae (Ericaceae). V. The genus *Coilostigma*

E. G. H. OLIVER*

Keywords: Cape Province, *Coilostigma,* Ericaceae, Ericoideae, morphology, phytogeography, pollination biology, taxonomy

ABSTRACT

A revision of the genus *Coilostigma* Klotzsch is presented which recognizes only two species, *C. zeyherianum* Klotzsch and *C. glabrum* Benth. The genus belongs to the Ericaceae — Ericoideae and is endemic in the southern and eastern Cape Province. Fundamental differences in the ovary complement have necessitated the recognition of two subgenera, *Coilostigma* and *Anomalosepala* E. G. H. Oliver. Aspects covered include history, morphology, phytogeography, pollination biology and taxonomy.

UITTREKSEL

Hierdie is 'n hersiening van die genus *Coilostigma* Klotzsch waarin net twee spesies, *C. zeyherianum* Klotzsch en *C. glabrum* Benth., erkenning geniet. Die genus behoort tot die Ericaceae — Ericoideae en is endemies in die suidelike en oostelike dele van die Kaapprovinsie. Basiese verskille van die vrugbeginsel-komplement noodsaak die erkenning van twee subgenera, *Coilostigma* en *Anomalosepala* E. G. H. Oliver. Aspekte wat bespreek word sluit in geskiedenis, morfologie, fitogeografie, bestuiwingsbiologie en taksonomie.

HISTORICAL OUTLINE

The genus *Coilostigma* was described by Klotzsch (1838) in his major revision of the Ericoideae. He based it on his three new species, *C. tenuifolium, C. zeyherianum* and *C. dregeanum,* all from the eastern Cape Province, and all possessing an unequal calyx.

Bentham (1839), in his revision of the family for De Candolle's *Prodromus,* retained the genus but redefined it to incorporate his new species, *C. glabrum,* and Klotzsch's monotypic genus *Thamnium, T. puberulum.* He formed two sections within the genus, namely *Eucoilostigma* and *Thamnium.* The inclusion of the superficially similar *Thamnium puberulum* ignored the feature of the unequal calyx for *Coilostigma.* Bentham (1876) took a conservative view of the family in Bentham & Hooker's *Genera* and sunk both *Coilostigma* and *Thamnium* under the genus *Scyphogyne* Brongn. Drude (1897) followed Bentham's latter treatment of the genera.

In *Flora capensis,* Brown (1906) retained the circumscription of the genus as applied by Bentham (1839) but ignored the sectional subdivision. He removed the discordant *C. puberulum* to *Thoracosperma.* All these changes were retained by Phillips (1926) in the first edition of his *Genera.* Later, however (Phillips 1944), he proposed a completely different classification of the family in South Africa, implemented in the second edition of his *Genera* (Phillips 1951). He reduced the number of genera to only eight, including *Erica* L. This action in some cases placed totally unrelated genera together. He placed *Coilostigma* under *Salaxis* Salisb.

MORPHOLOGY

The plants of *Coilostigma* are typical ericoid woody shrublets with one species, *C. zeyherianum,* being single-stemmed and the other, *C. glabrum,* a multi-stemmed coppicing shrublet. Most of the other vegetative characters are very similar in both species.

The bract is totally recaulescent in *C. zeyherianum* (Figure 4,1), only very rarely partially so, and forms part of the calyx as the large abaxial member in what is referred to as an unequally 4-lobed calyx. In *C. glabrum,* on the other hand, the bract is variable in position and with the calyx exhibits a remarkable diversity of form. It is variably recaulescent within any one inflorescence, with the lowest whorl of flowers having a partially recaulescent bract and the upper whorl a totally recaulescent bract. When the bract is partially recaulescent the calyx can be either:

(1) 4-lobed with two normally sized lateral lobes (sepals) and very reduced ad- and abaxial lobes (sepals) (Figure 5,2), or

(2) 4-lobed with two lateral lobes (sepals) and an adaxial lobe (sepal) and a larger less fused abaxial lobe (bract) (Figure 5,1), or

(3) 3-lobed with two lateral lobes (sepals) and a slightly reduced adaxial (sepal) and no abaxial lobe (bract or sepal), or

(4) 2-lobed with only two normally-sized lateral lobes (sepal), the ad- and abaxial lobes (bract and sepal/s) being absent.

As in all species of the Ericoideae with an unequal calyx the bracteoles are totally absent in all flowers. This is also the case where the bract is only partially recaulescent.

The pollen in both species occurs as single tricolporate grains with scabrate sculpturing in *C. zeyherianum* and no sculpturing in *C. glabrum* (Figure 1).

The ovary displays two distinct types. In *C. glabrum* it is 4-, rarely 3-locular, regular in shape and hairy with a single ovule in each locule. In *C. zeyherianum* the ovary is only 2-locular, flattened and glabrous.

As a result of ovary characters the fruit is very different in shape in the two species. In *C. glabrum* it

* Botanical Research Unit, P.O. Box 471, Stellenbosch 7600.

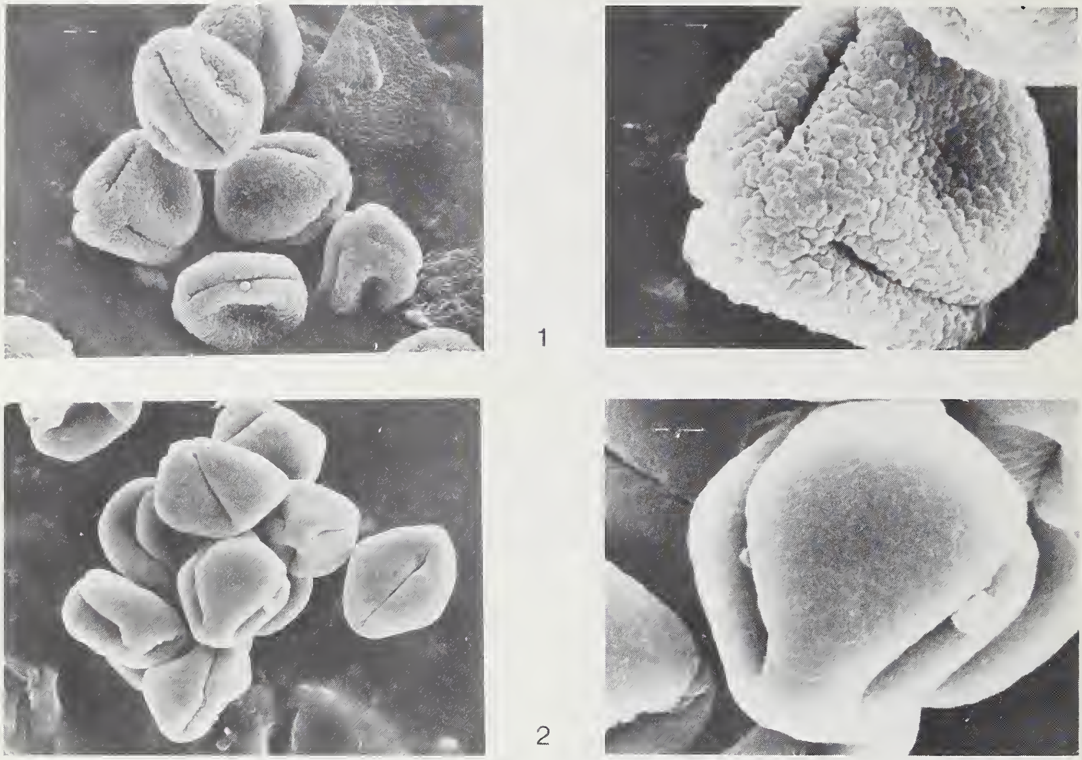

FIGURE 1. — Pollen of the species of *Coilostigma*. 1, *C. zeyherianum (Oliver 7949)*; 2, *C. glabrum (Oliver 8801)*. Scanning electron micrographs, left hand × 1000, right hand × 3000.

is regular or slightly irregular with usually only one of the developed seeds being fertile. In *C. zeyherianum* the fruit is mostly irregular due to the development of only one fertile seed and is only occasionally 2-seeded, and regularly complanate. In both species the seed is extremely difficult to remove from the fruit in the dry state. This indicates that the whole flower is shed as the propagule and must disintegrate or be wetted prior to germination.

The seeds are similar in both species and are typically ericoid in form, i.e. spherical with a hard reticulate testa (Figure 2). This type of seed is normally associated within the Ericoideae with a dehiscent capsule as in the genera *Erica* L., *Blaeria* L., *Philippia* Klotzsch and *Ericinella* Klotzsch. The indehiscent fruit and ericoid seed in this genus is shared with genera such as *Coccosperma* Klotzsch, *Thamnus* Klotzsch and *Platycalyx* N.E. Br. and can be regarded as a stage in the evolution of the indehiscent soft-seeded fruits found in the more 'advanced' genera within the subfamily.

GENERIC DELIMITATION AND RELATIONSHIPS

The genus *Coilostigma*, as recognized in this revision, is characterized by the possession of a totally recaulescent bract forming an unequally 4-lobed calyx, a 4-lobed corolla, four free stamens, bilobed anthers, single pollen grains, a 2-, 3- or 4-locular ovary with a single pendulous ovule in each locule, an indehiscent dry berry and seeds with a hard testa.

With this circumscription *Coilostigma* is somewhat isolated within the Ericoideae. The 2-locular 1-seeded ovary of *C. zeyherianum* is a character found in a number of genera, namely *Grisebachia* Klotzsch, *Eremia* D. Don *(pro parte)*, *Sympieza* Klotzsch, *Platycalyx*, *Simocheilus* Klotzsch, *Acrostemon* Klotzsch and *Arachnocalyx* Compton, all however with an equal calyx. Only in *Platycalyx* is there a possibility of a close relationship in that the fruiting stage is a similar dry berry with hard-walled seeds. In the other genera the evolutionary reduction has resulted in soft-walled seeds.

The 4-celled 1-seeded ovary in *C. glabrum* is a character which the subgenus *Anomalosepala* shares with *Philippia* and *Ericinella*, both of which have an unequal calyx and hard-walled seeds but with many seeds per locule in a dehiscent capsule. It is also shared with the equal-calyxed genera *Erica*, *Blaeria*, *Eremia (pro parte)* and *Thoracosperma* Klotzsch. The first two have numerous seeds per locule in a dehiscent capsule. *Eremia* has a very similar ovary and fruit but flowers totally different in appearance apart from the equal calyx. *Thoracosperma* on the other hand has rather similar looking flowers, especially in *T. puberulum* (cf. Historical Outline), but with a fruit that contains soft, thin-walled seeds.

There is therefore no clear-cut relationship for this genus within the subfamily. It has probably been derived from some *Erica-Blaeria-Philippia* ancestral stock. A detailed analysis of relationships and possible evolutionary paths will be published when the revision of all the 'minor' genera of the Ericoideae has been completed.

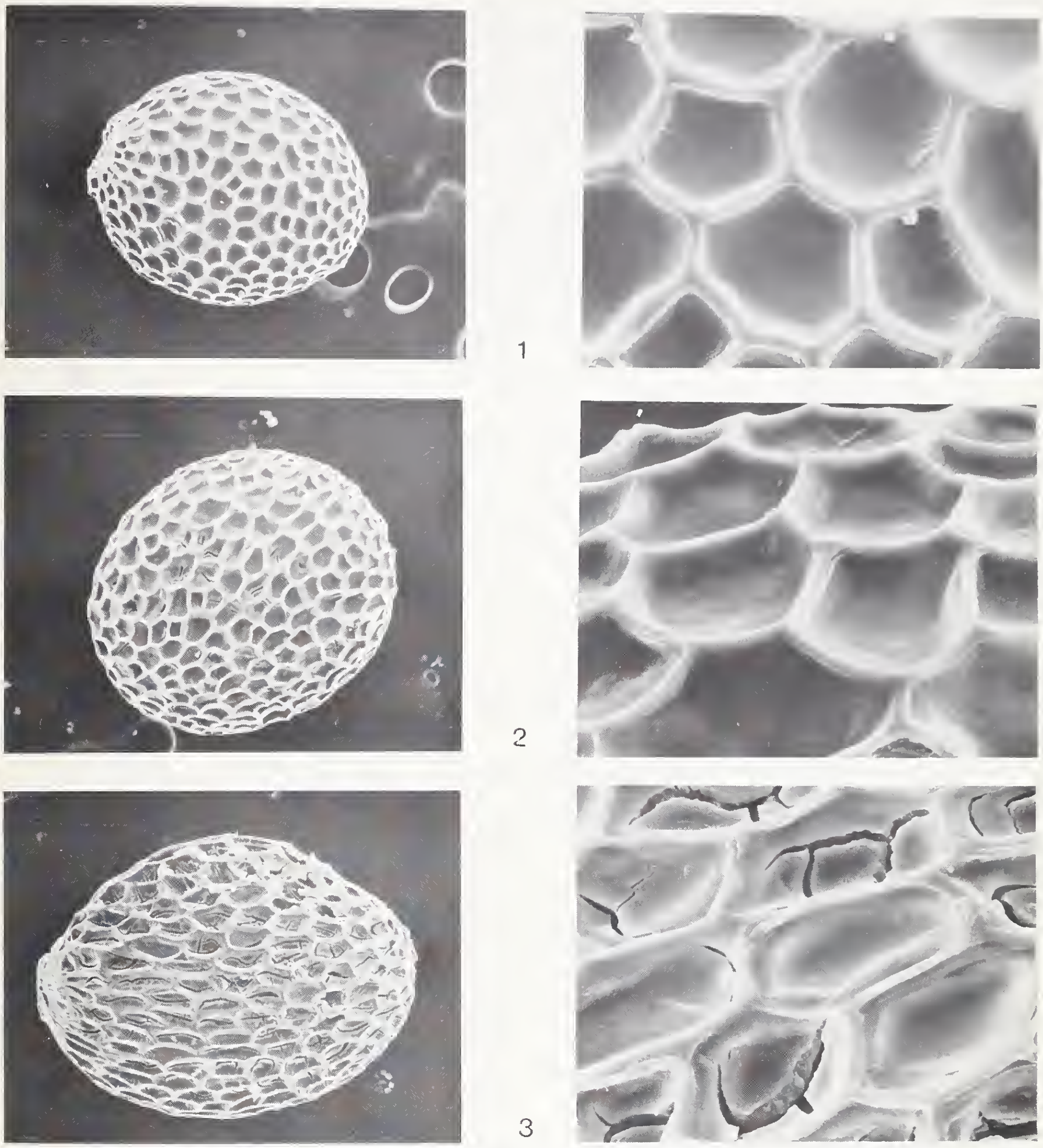

FIGURE 2. — Seeds of the species of *Coilostigma*. 1, *C. zeyherianum* var. *zeyherianum (Oliver 7949)*; 2, *C. zeyherianum* var. *tenuifolium (Oliver 7948)*; 3, *C. glabrum (Oliver 8817)*. Scanning electron micrographs, left hand × 40, right hand × 200.

PHYTOGEOGRAPHY

The genus *Coilostigma* is endemic in the southern and eastern parts of the Cape Province (Figure 3) corresponding to the Langeberg and South Eastern Phytogeographical Centres proposed by Weimarck (1941). This falls within the limits of the Cape Floral Region (Weimarck 1941; Goldblatt 1978; Oliver *et al.* 1983). The extended distribution of *C. zeyherianum* further eastwards to areas near Alexandria and Grahamstown makes the genus the only endemic one in the Cape to extend beyond the strict limits of the Cape Floral Region as defined by Goldblatt (1978). The Grahamstown area can be regarded as a depauperate relictual extension of the Cape Flora proper (Bond & Goldblatt 1984).

The genus is one of only two in the Ericoideae in the Cape Floral Region with an eastern distribution, all the others having their main centres in the south-western Cape. The other eastern genus is the monotypic *Thamnus*. *Thoracosperma* is a southern genus only just represented in the south-western Cape by *T. puberulum*.

The disjunction between the distribution ranges of the two species (Figure 3), which is quite considerable in terms of Ericoideae in the Cape Floral Region, remains inexplicable. *C. glabrum* is very localized in one population on the northern drier slopes of the low range of hills just south of the Langeberg near Riversdale. Here it receives a fairly high annual rainfall of ± 800 mm which can be throughout the

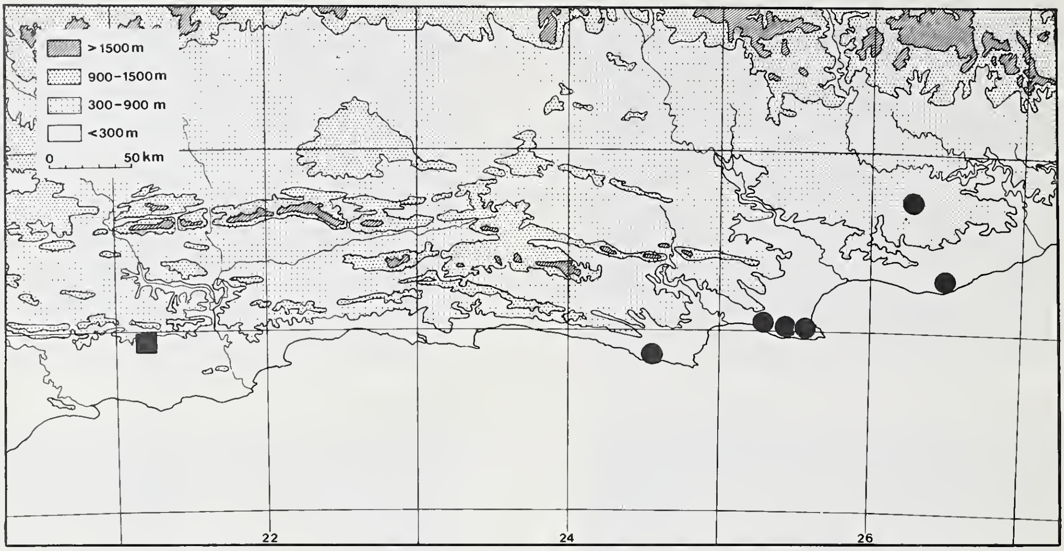

FIGURE 3. — Distribution of *C. glabrum*, ■; *C. zeyherianum*, ●.

year but is mainly in the winter months. *C. zeyherianum* is mainly concentrated on the coastal plains in the Humansdorp/Port Elizabeth area where it grows on sandy flats with an annual rainfall of 700–900 mm falling throughout the year. The outlying population on the coast near the mouth of the Boesmansrivier could well occur on sand as well as the inland population just east of Grahamstown because the latter area has flora with some coastal affinities (Jacot Guillarmod pers.comm.).

POLLINATION BIOLOGY

In the light of the findings of Rebelo, Siegfried and Oliver (1985) most of the floral features of the two species are consistent with the anemophilous syndrome: 1, the stigma is enlarged, subinfundibuliform to peltate; 2, the stamens are exserted (exserted stamens were, however, found to be more generally important in ornithophilous and entomophilous species within the subfamily); 3, the pollen grains are small, non-sticky and easily shed; 4, there is no sign of development of nectaries below the ovary, and 5, the corolla in *C. zeyherianum* is inconspicuous, pale yellow, soon turning brown. However, the corolla in *C. glabrum* is dark pink, a colour that could be expected to act as an attractant to insects.

This situation is similar to that existing in *Ericinella multiflora* Klotzsch in which the pollen could be the reward for any visiting insects attracted by the colour of the flowers.

It is surprising that the typically anemophilous genera, namely *Philippia, Salaxis, Coccosperma, Scyphogyne* Brongn. and *Nagelocarpus* Bullock all have an unequal calyx (totally recaulescent bract) but, in contrast to our genus, they have pollen grains in tetrads.

The occurrence of anemophily in the genus was verified in the field when small clouds of pollen were seen to be emitted from the plants when disturbed.

COILOSTIGMA

Coilostigma *Klotzsch* in Linnaea 12: 234 (1838); Benth.: 708 (1839); N.E. Br.: 327 (1906); E. G. H. Oliver: 437 (1975).

Salaxis sensu Phillips: 71 (1944), pro parte; Phillips; 561 (1951), pro parte.

TYPE: *C. zeyherianum* Klotzsch (lectotype chosen here).

Perennial woody shrublets, single- or multistemmed, up to 1 m tall. *Branches* lacking infrafoliar sterigmata or ridges. *Leaves* 3-nate, erect imbricate, ericoid, sulcate, linear. *Inflorescence* of 1–3, rarely 4, whorls of 3-nate small flowers at the ends of branches (mesoblasts) and lateral absolute or partial brachyblasts scattered along the mesoblasts, occasionally clustered towards the ends into compound heads; pedicel short, relative to the flower. *Bract* partially recaulescent and foliaceous in the lowest flowers to fully recaulescent in any one inflorescence or always fully recaulescent; bracteoles absent. *Calyx* unequally (2)3(4)-lobed excluding or including the totally recaulescent bract as the abaxial member, lateral lobes usually slightly larger, reduced abaxial sepal sometimes present, adaxial sepal sometimes reduced or absent, sepals ⅛–⅓ the length of the corolla. *Corolla* 4-lobed, tubular to narrowly ovoid to urceolate, glabrous or hirsute, pale yellow to white, or pink; lobes short, erect to slightly spreading. *Stamens* 4, free, exserted or included by abortion; filaments linear; anthers bilobed, muticous, dorsifixed near the base, thecae oblong, pore $\frac{1}{10}$–$\frac{1}{7}$ the length of the theca; pollen grains single, tricolporate. *Ovary* 2(3)4-locular with a single pendulous ovule per locule, transversely broadly obovate, complanate or globose, glabrous or puberulous; style filiform, exserted; stigma broad, peltate to subinfundibuliform with 2(3) or 4 stigmatic processes. *Fruit* an indehiscent berry with a thin, rather dry, leathery pericarp, irregularly obovoid with only one seed developed from a 2-locular ovary or glob-

ose from a 4-locular ovary; seeds ovoid to spherical with a hard reticulate testa.

A genus of only two species, endemic in the southern and eastern Cape Province, southern Africa. The name is derived from the Greek *coilos* 'hollow' and stigma.

The two species exhibit distinct fundamental differences in ovary characters necessitating recognition at subgeneric level.

KEY TO THE SUBGENERA AND SPECIES

Ovary 2- rarely 3-locular, glabrous .... Subgenus *Coilostigma*
.... 1. *C. zeyherianum*
Ovary 4- rarely 3-locular, puberulous ... Subgenus *Anomalosepala*
.... 2. *C. glabrum*

Subgenus **Coilostigma**

Coilostigma Klotzsch in Linnaea 12: 234 (1838); N.E. Br.: 327 (1906), pro parte; E. G. H. Oliver: 437 (1975).

Coilostigma sect. *Eucoilostigma* Benth.: 708 (1839).

Scyphogyne sect. *Coilostigma* Benth.: 594 (1876).

Type: *C. zeyherianum* Klotzsch.

Shrub single-stemmed; bract totally recaulescent; calyx unequally 4-lobed with the recaulescent bract as the abaxial lobe and 3 sepals; ovary 2-locular; fruit irregularly obovoid, complanate.

1. **Coilostigma zeyherianum** *Klotzsch* in Linnaea 12: 234 (1838); N.E. Br.: 328 (1905). Type: In montibus 'Van Stadensriviersberge' *Ecklon & Zeyher s.n.* (B†, BOL!, E!, K!, LD!, MEL!, P!, S!, UPS!, W!, Z!); idem as *296* (G!, MO!, W!). Lectotype (chosen here): *Ecklon & Zeyher s.n.* (BOL).

Erect, single-stemmed perennial shrub up to 1 m tall. *Branches* subflexuose, puberulous, without sterigmata, bark splitting irregularly with age. *Leaves* erect, imbricate, 1,5–3,0 mm long, linear acute to obtuse, rounded below, flat above, glabrous, edged with a few sessile glands and some hairs; petiole 0,5 mm long, appressed, glabrous, edged with sessile glands. *Flowers* 1–6(9)(12) at the ends of the branches (mesoblasts) and lateral brachyblasts scattered along the branches, occasionally clustered towards the ends of the branches; pedicel 0,3–0,6 mm long, glabrous or puberulous. *Bract* totally recaulescent as abaxial lobe of the calyx. *Calyx* unequally 4-lobed, joined at the base, large lobe abaxial, 0,7–2,0 mm long and foliaceous, ± ⅓ as long as to equal the length of the corolla, occasionally longer, other lobes 0,4–0,6 mm long, oblong to narrowly deltoid, the laterals slighter larger and the adaxial sometimes reduced, all glabrous to puberulous at the base and ciliate. *Corolla* 1,5–2,5 mm long, tubular to narrowly ovoid to urceolate, tangentially complanate in the fruiting stage, glabrous or hirsute, dirty pale yellow to brown; lobes erect or very slightly spreading, ± ⅛ the length of the tube. *Stamens* exserted or by abortion included; filaments 1,7–2,0 mm long, linear, glabrous; anthers 0,5–1,0 mm long, thecae oblong, dorsifixed near the base, muticous, sparsely strigulose, pore ± 1/10 the length of the theca. *Ovary* 2-locular, 0,5 × 0,6 mm, transversely broadly obovate, complanate, glabrous; style filiform, ± 2,5 mm long, exserted; stigma 0,6 mm broad, peltate to subinfundibuliform with 2 stigmatic processes. *Fruit* irregularly obovoid, 0,7–0,8 mm long; seeds ovoid to spherical, 0,6–0,8 mm long/diam., reticulate, cells ± angular-circular, ridges straight. Figure 4.

A species forming erect shrublets, occurring on sandy plains near the coast from south of Humansdorp eastwards to Kenton-on-Sea flowering from January to December depending on the locality.

A taxon containing two distinct varieties which occur growing together in most populations.

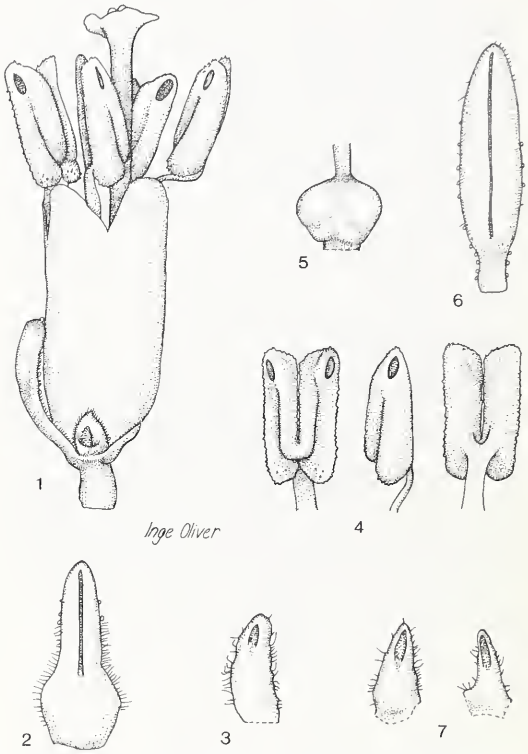

FIGURE 4. — *C. zeyherianum*. 1, flower; 2, bract (abaxial segment of the calyx); 3, lateral sepal; 4, anther, front, side and back views; 5, ovary; 6, leaf; all drawn × 25 from *Oliver 7949* (STE); 7, sepals, lateral and adaxial; drawn × 25 from *Ecklon & Zeyher s.n.* (BOL).

KEY TO THE VARIETIES

Flowers glabrous .... 1a. var. *zeyherianum*
Flowers pubescent .... 1b. var. *tenuifolium*

1a. var. **zeyherianum**

Coilostigma zeyherianum Klotzsch: 234 (1838); N.E. Br.: 328 (1905). Lectotype (chosen here): *Ecklon & Zeyher s.n.* (BOL).

C. dregeanum Klotzsch: 235 (1838); N.E. Br.: 1127 (1909). Type: P.b.sp., *Drège 7753* (B†, K, fragm.!; BOL, fragm.!); idem *s.n.* (G!, G-DC!).

Flower with completely glabrous corolla.

Vouchers: *Oliver 7936* (GRA, NY, P, PRE, S, STE); *7946* (BM, BOL, E, K, NBG, MO, PRE, STE).

1b. var. **tenuifolium** *(Klotzsch) E. G. H. Oliver,* comb. et stat. nov. Types: In planitie inter 'Kraka-

kamma' et montes 'Vanstadensriviersberge', *Ecklon & Zeyher s.n.* (B†, E!, S!); idem as *294* (G!, GOET!, LD!, M!, MEL!, MO!, S!, W!, UPS!, Z!); in sylvis 'Olifantshoek' prope flumen 'Bosjesmansrivier', *Ecklon & Zeyher s.n.* (B†, BOL!). Lectotype (chosen here): Ecklon & Zeyher s.n. (S).

Flower with pubescent to hirsute corolla, otherwise as in the typical variety.

Vouchers: *Oliver 7935* (GRA, NY, P, PRE, S, STE); *7945* (BM, BOL, E, K, NBG, MO, PRE, STE).

Klotzsch (1838) described three species, *C. tenuifolium, C. zeyherianum* and *C. dregeanum,* when he created the genus *Coilostigma.* These he based on differences in corolla hairiness, sepal shape and branch thickness. An examination of all subsequent collections has shown the sepal shape and branch characters to be continuously variable over the whole distribution range and therefore unreliable for taxonomic delimitation.

There is discontinuity in the indumentum of the corolla where material can easily be placed in glabrous or pubescent to hirsute groups. During field investigations of five widely separated populations in the Port Elizabeth to Humansdorp area, I found that both forms did occur together to a varying degree in each population and that no intermediates existed. I consider this type of discontinuity worthy of recognition at varietal level.

Even though the species is recorded as widespread on the flats it is today by no means common. Its habitat is being inundated by alien vegetation, in particular the Port Jackson Willow, *Acacia saligna* (Labill.) Wendl., or it is being destroyed by housing estates or farming practices. In the Port Elizabeth area plants are very difficult to find nowadays in places where they must have been abundant in the past. A small population could survive in the reserve alongside the railway line in Walmer.

The best populations I found occurred on the flats west of the mouth of the Slangrivier south-west of Humansdorp, but here the recently applied agricultural practice of bush-cutting for pasturage is decimating the species. Only on the outcrops of low stable dunes or in the dune slacks too small to manoeuvre in, does the species still manage to survive and form almost pure stands.

The populations near the mouth of the Boesmansrivier have undoubtedly disappeared as the sandy habitat is also ideal for farming in the area. Reported populations at Slaaikraal and Coldsprings west of Grahamstown could not be located. It seems unlikely that the species should occur so far inland, but Dr A. Jacot Guillarmod assures me that vegetation elements with coastal affinities do occur in that area.

Subgenus **Anomalosepala** *E. G. H. Oliver,* subgen. nov. a subgen. typico frutice caulibus multis, bractea perfecte vel partim recaulescenti, calyce inaequaliter (2)3(4)-lobato; ovario (3)4-loculari, fructu regulariter globoso differt.

Coilostigma sect. *Thamnium* (Klotzsch) Benth.: 708 (1839), pro parte.

Scyphogyne sect. *Thamnium* (Klotzsch) Benth.: 594 (1876), pro parte.

Coilostigma N.E. Br.: 327 (1906), pro parte; E. G. H. Oliver: 437 (1975), pro parte.

Type: *C. glabrum* Benth.

Shrub multi-stemmed; bract partially to totally recaulescent in any one inflorescence; calyx unequally (2)3(4)-lobed; ovary (3)4-locular; fruit globose, regular.

2. **Coilostigma glabrum** *Benth.* in De Candolle, Prodromus 7: 708 (1838); N.E. Br.: 328 (1905).

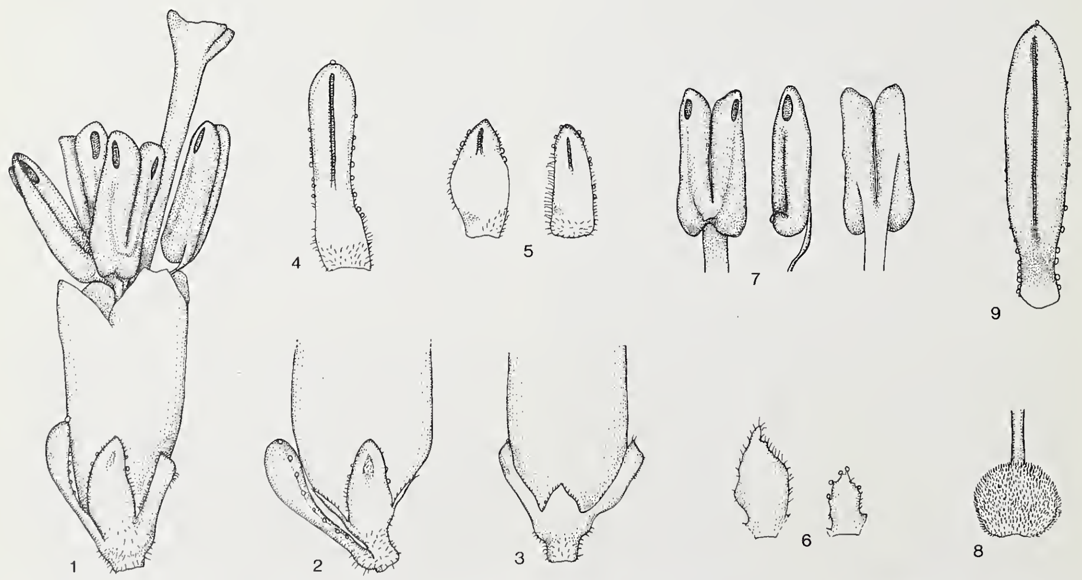

FIGURE 5. — *C. glabrum.* 1, flower; 2, lower part of flower showing partially recaulescent bract and very reduced ab- and adaxial sepals; 3, lower part of flower showing reduced adaxial sepal; 4, bract (abaxial segment of the calyx); 5, sepals, lateral and adaxial; 6, reduced adaxial sepals; 7, anther, front, side and back views; 8, ovary; 9, leaf. All drawn × 25 from *Oliver 8801* (STE).

Type: In Cape Colony, *Burchell 6875* (K, holo.!; BOL, fragm.!).

Erect multi-stemmed shrublet up to 500 mm tall, stems arising from a woody rootstock. *Branches* straight, fastigiate, slender, sparsely and shortly puberulous, sterigmata absent; bark grey, splitting irregularly. *Leaves* erect, imbricate, 2,0–3,0 mm long, linear to linear-lanceolate, obtuse, sulcate, rounded below, flat above, glabrous, edged with a few sessile glands; petiole appressed, 0,4–0,6 mm long, ciliate with short hairs and sessile glands. *Flowers* 1–9 at the ends of branches (mesoblasts) and of lateral very short brachyblasts often crowded towards the ends of the branches or subverticillate; pedicel very short, 0,1–0,4 mm long, puberulous. *Bract* partially recaulescent, 0,9–1,2 mm long, subfoliaceous, oblong and basal in position in the lowest flowers in any one inflorescence to fully recaulescent, subequal and joined to the lateral calyx lobes in the upper flowers, glabrous, ciliate with short hairs and sessile glands. *Calyx* (2)3(4)-lobed slightly joined, all equal or the 2 laterals 0,7–0,9 mm long, narrowly ovate and the ad- and abaxial lobes variously reduced, 0,1–0,8 mm long, narrowly ovate to broadly deltoid or absent, all ciliate with short hairs and sometimes sessile glands, glabrous but puberulous at the base, the large lobes acute with slightly sulcate apex. *Corolla* 1,8–2,4 mm long, tubular to narrowly campanulate to narrowly ovoid, bulging out adaxially when the sepal is absent, glabrous, pale to dark pink, lobes erect to slightly spreading, ± ⅙ the length of the tube. *Stamens* exserted, occasionally included by abortion; filaments linear, 1,2 mm long, often subsigmoid just below the anther; anthers muticous rarely minutely decurrent-aristate, glabrous, oblong, occasionally cuneate; thecae oblong, obtuse, 0,8–1,2 mm long, dorsifixed near the base, occasionally prognathous at the base; pore ± ⅐ the length of the theca. *Ovary* 4(3)-locular with a single pendulous ovule in each locule, globose, 0,5 × 0,6 mm, densely puberulous; style exserted, filiform, 2,5–3,0 mm long, glabrous; stigma subinfundibuliform, 0,5 mm wide, glabrous. *Fruit* globose, 1,0 × 0,9 mm, puberulous; seeds broadly ellipsoid, ± 0,8–0,9 mm long, testa reticulate, cells ± elongate, ridges straight. Figure 5.

A species forming compact coppicing shrublets up to 500 mm tall; confined to a few silcrete hills near Garcia's Pass in the Riversdale area of the southern Cape Province and flowering from October to January.

This species was until recently only known from the type collection made in November 1814 by Burchell. The population, consisting of only 24 plants on the Kleinberg north-west of Riversdale, corresponds very closely to the more exact locality on Burchell's specimens 'between Kleine Vet River and foot of Langeberg'. The species appears to be very rare.

The row of hills forming the ridge just south of the Langeberg Mountains could well have additional populations of *C. glabrum* on it. However, the plants are rather inconspicuous and would seem to flower most profusely a year or two after a fire. Being copious resprouters the plants grow quickly and flower sooner than the surrounding reseeders and are then more conspicuous.

The species is remarkable in the whole subfamily for the degree of variability in the form and arrangement of the calyx. Even within a single inflorescence the calyx may vary considerably. In the genus *Sympieza* the calyx may vary from 2–4-lobed in a single inflorescence, but in that genus there is no partially to fully recaulescent bract to complicate the issue.

The above variability within the calyx is confined to *C. glabrum* and does not occur in the commoner and more widespread *C. zeyherianum*.

Vouchers: *Oliver 7548* (BOL, K, MO, NBG, PRE, S, STE); *8801* (BM, E, G, NY, P, PRE, S, STE, UPS, W).

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SPECIMENS EXAMINED

Anderson 279 (1) GRA.

Batten s.n. (1) NBG; *Blake s.n.* (1) STE; *Bodkin sub Bolus 6693* (1) BOL, PRE; *H. Bolus 9803* (1) BOL, PRE; *L. Bolus in BOL 27094 & 27905* (1) BOL; *Burchell 6875* (2) BOL, K.

Drège 7753 (1) K, S; *s.n.* (1) G-DC.

Ecklon & Zeyher 294 (1) G, LD, M, MEL, MO, S, UPS, W, Z; *296* (1) G, MEL, MO, W; *s.n.* (1) BOL, E, GRA, MEL, K, P, PRE, S, W, Z.

Fourcade 2151 (1) BOL, K, NBG, STE; *2152* (1) BOL, K.

Long 301 (1) GRA, K, PRE; *302* (1) K, PRE; *303* (1) BOL, K; *Lynes 99* (1) BM; *s.n.* (1) BM.

Mund s.n. (1) BOL.

Oliver 4492 (1) PRE, STE; *4494* (1) (STE); *7548* (2) BOL, K, MO, NBG, PRE, S, STE; *7935 & 7936* (1) GRA, NY, P, PRE, S, STE; *7939* (1) STE; *7940* (1) PRE, STE; *7942* (1) PRE, STE; *7943* (1) STE; *7945 & 7946* (1) PRE, STE; *7948 & 7949* (1) BM, BOL, E, K, NBG, MO, PRE, STE; *8801* (2) B, BM, E, G, MO, NY, P, PRE, S, STE, UPS, W; *8802* (2) STE; *8817* (2) PRE, STE.

Paterson 1145 (1) GRA, Z; *1156* (1) GRA; *2290* (1) Z; *Pole Evans 18277* (1) PRE.

Rogers 28662 (1) GRA.

Sim 36 (1) BOL.

Trash 9 (1) GRA.

West 279 (1) BOL.

Zeyher 719 (1) BM, BOL, K, PRE; *3236* (1) GRA, MEL, P, PRE; *3321* (1) GRA, MEL, P, W; *s.n.* (1) BOL, K.

Bothalia 17,2: 171–177 (1987)

Synopsis of the genus *Salix* (Salicaceae) in southern Africa

K. L. IMMELMAN*

Keywords: phytogeography, Salicaceae, *Salix*, southern Africa, taxonomy

ABSTRACT

One species of *Salix*, *S. mucronata* Thunb. (=*S. subserrata* Willd.), with five subspecies, is recognized as indigenous to the southern African region. Problems of delimitation in the genus in southern Africa are discussed, and a key to the indigenous and exotic taxa is presented. The synonymy of the subspecies is presented, with leaf silhouettes and a distribution map of each. The following new combinations are made: *S. mucronata* subsp. **hirsuta** (Thunb.) Immelman, *S. mucronata* subsp. **capensis** (Thunb.) Immelman, *S. mucronata* subsp. **woodii** (Seemen) Immelman and *S. mucronata* subsp. **wilmsii** (Seemen) Immelman.

UITTREKSEL

Een *Salix*-spesie, *S. mucronata* Thunb. (=*S. subserrata* Willd.), met vyf subspesies, word erken as inheems in die suider-Afrikaanse gebied. Probleme met omgrensing in die genus in suidelike Afrika word bespreek, en daar is 'n sleutel tot die inheemse en uitheemse taksons. Die sinonimie van die subspesies word gegee, met blaarsilhoeëtte en 'n verspreidingskaart van elk. Die volgende nuwe kombinasies word gemaak: *S. mucronata* subsp. **hirsuta** (Thunb.) Immelman, *S. mucronata* subsp. **capensis** (Thunb.) Immelman, *S. mucronata* subsp. **woodii** (Seemen) Immelman en *S. mucronata* subsp. **wilmsii** (Seemen) Immelman.

INTRODUCTION

Identification of taxa within the genus *Salix* in southern Africa is difficult for the following reasons: 1, all species are dioecious; 2, spring leaves, which are present when the flowers first appear, differ considerably from summer leaves, and are similar in all the southern African material; 3, flowers and fruits are similar in all the taxa; 4, leaf and pubescence characters are highly variable within the taxa, so that it is difficult to discern a pattern.

METHODS

Specimens were borrowed from all major South African herbaria, as well as from Windhoek and Harare. The following macromorphological characters were examined: leaf size, shape and margins; petiole length; pubescence of leaves and twigs; and structure of flowers and fruits. The glands in male and female flowers were examined. The number of stamens in the male flowers was counted, because this character has been often used to distinguish species of *Salix* in other parts of the world. Adaxial and abaxial leaf surfaces, as well as pollen and seeds, were viewed with the SEM.

RESULTS

No taxonomically useful results were obtained from either the SEM examinations or the stamen counts. The number of stamens varied from 3–12 per flower, and varied even within the same inflorescence. The glands of both male and female flowers varied considerably, with 2 to numerous glands in the male flower and a glandular ring in the female. This ring varied from entire to deeply lobed, the number and size of the lobes being irregular, but it did not present any pattern. Fruits and flowers of all southern African specimens were found to be essentially similar.

Leaf length, breadth, proportions and margin, pubescence of both leaves and twigs, and petiole length, however, did differ between taxa, and these differences were correlated with distribution. In northern SWA/Namibia, the south-western Cape and the northern Transvaal, the summer leaves are large, relatively broad, glabrous or sometimes with grey canescence, and have either entire or toothed margins. Around the Olifants River (south-western Cape) the leaves are similar in shape to the above but have a dense covering of long silvery trichomes. Specimens from the rest of the Cape Province, including the Orange River system, and extending along the Vaal into the Transvaal and Orange Free State, and into Lesotho, have short, relatively broad leaves, always toothed and glabrous, with short petioles and glabrous twigs. Plants from Natal and most of the Transvaal (excluding the Vaal and its tributaries), have long narrow leaves, always toothed, with longer petioles and (usually) grey-canescent twigs. Plants with larger, broader leaves, nearly always with entire margins, occur in the Transvaal Lowveld and escarpment from Swaziland to the northern Transvaal border and into Zimbabwe.

DISCUSSION

It was difficult to distinguish clearly any of the taxa morphologically, except the Olifants River taxon which has densely silvery-pubescent leaves. Most characters showed at least some overlap and, in the case of the Transvaal Lowveld taxon, the characters were especially variable. However, it is possible to recognize most specimens as belonging to one or other of several taxa and, in addition, the

* Botanical Research Institute, Private Bag X101, Pretoria 0001.

variation is geographically correlated. For these reasons it was decided not to place all indigenous plants in a single highly polymorphic taxon. Burtt Davy (1922) in his study of the genus in the whole of Africa, was the first to suggest that each species or variety of *Salix* was restricted to a certain drainage basin(s). In southern Africa at least, this conclusion can be accepted, though distributions of the taxa do overlap to some degree in the south-western Cape and to a larger extent in the Transvaal. Each taxon shows a well defined range and for this reason, although the morphological differences are small, the taxa are recognized at subspecific rather than varietal level.

It is not certain whether the variability and intergrading of characters is due to inter-taxon hybridization since no attempt has been made to hybridize the indigenous taxa under controlled conditions. It is possible that *S. mucronata* subsp. *wilmsii* is a hybrid between subsp. *woodii* and subsp. *mucronata.* It is in many ways intermediate between these two subspecies, it occurs within the range of both, and it exhibits a great range of variation within the subspecies. Its variation, however, may also be ascribed to inter-taxon diversity. Therefore, until experimental studies have been done, it appears best to maintain it as a separate taxon. The taxa are difficult to identify because the differences between them are both small and variable. A further difficulty results from the fact that there is a great difference on each plant between the spring (immature) and summer (mature) leaves. It is preferred to call them spring and summer leaves respectively, as 'immature' implies further development, whereas the leaves maintain their differences even when growth is complete. The spring leaves are smaller, broader in proportion to their length, often obovate, the margins are entire and the apices may be rounded rather than acute. The transition to summer leaves is gradual, but is usually complete by November. In the following key, only specimens collected from November to May have been considered. For specimens collected at other times of the year the locality may present the only clue to identity. Unfortunately, as stated earlier, no flower or fruit characters were found to distinguish taxa. This made the identification of type specimens difficult, as a number were collected in spring and in some cases no locality was given.

It is often stated that the southern African taxa do not have stipules. Examination of fresh material of subsp. *woodii,* however, showed that this was not strictly true, as vestigial stipules are present on young twigs. These are ± 1 mm long, thick in texture, and are later deciduous; in dry herbarium material they are not noticeable. *S. mucronata* subsp. *mucronata* does have stipules further north in its range, but not within southern Africa.

A few exotic species appear to have become naturalized in southern Africa, and are included in the key. *S. babylonica* (Weeping Willow) (Figure 1.13) is widespread and well known, while the other species, from the few specimens available, appear to be more restricted. No specimens have been seen which appear to represent hybrids between the indigenous and exotic taxa. More collecting of exotic willows is needed, together with information about whether they are cultivated, naturalized or spreading. Only female plants of the exotic species are present in this country, and none of the specimens seen were male.

KEY TO SPECIES AND SUBSPECIES

1a Tree with branches hanging vertically; leaves tapering to a long acuminate apex (whip-tip); female flowers sessile .... 2. *S. babylonica* L. (Figure 1.13)

1b Trees or shrubs, branches may droop but not hanging vertically; leaves acute or acuminate but not tapering to a long 'whip-tip'; female flowers and fruits sessile or pedicellate:

2a Branches ascending; stipules usually present, foliose or dentate, may be caducous; female flowers sessile (may be shortly pedicellate in *S. lasiandra):*

3a Basal 1–3 leaves on flowering shoots with long silky golden-white hairs on margin; female flowers with a single gland at base of ovary .... 4. *S. alba* L. (× *S. fragilis* L. ?)

3b Basal leaves on flowering shoots without long hairs on margin; female flowers with 2 glands at base of ovary:

4a Petiole with a pair of glands on upper side near junction with lamina; style at least 0,5 mm long; twigs not brittle at nodes .... 5. *S. lasiandra* Benth.

4b Petiole without glands; style very short or absent; twigs brittle at nodes .... 3. *S. fragilis* Benth.

2b Branches drooping; stipules, if present, minute and subulate, not dentate; female flowers and fruits sessile:

5a Leaves and branches densely silvery hirsute; found on the Olifants River (SW Cape) and its tributaries .... 1b. *S. mucronata* subsp. *hirsuta* (Figure 1.4)

5b Leaves and branches glabrous or grey-canescent; not found on the Olifants River:

6a Leaf lamina (8–) 14–23 mm wide, 3–5 (–7) times as long as wide; northern SWA/Namibia, SW Cape and occasionally N Transvaal .... 1a. *S. mucronata* subsp. *mucronata* (Figure 1.1–1.3)

6b Leaf lamina 5–20 mm wide, usually more than 5 times as long as wide; rarely in SW Cape, never in northern SWA/Namibia:

7a Summer leaves usually shorter than 65 mm; petioles 2–5 mm long; twigs always glabrous; mainly on Orange River and its tributaries, including the Vaal, and on rivers of the southern and eastern Cape as far north as Port Shepstone in Natal, occasionally found elsewhere .... 1c. *S. mucronata* subsp. *capensis* (Figure 1.5, 1.6)

7b Summer leaves usually longer than 60 mm; petioles 4–14 mm long; twigs grey-canescent to puberulous, sometimes glabrous; mainly on Limpopo and Olifants (Transvaal) Rivers and their tributaries, and on Natal rivers as far south as Port Shepstone:

8a Summer leaves usually entire, 10–20 mm wide; branches and young leaves often very densely grey-canescent; along Transvaal escarpment and into lowveld as far south as Swaziland, occasional specimens from other places.. .... 1e. *S. mucronata* subsp. *wilmsii* (Figure 1.10–1.12)

8b Summer leaves always toothed, 6–14 mm wide; branches and young leaves less densely canescent, may be puberulous or sometimes glabrous; along whole of drainage basin of Limpopo, Olifants (Transvaal) and Maputo Rivers, and Natal rivers as far south as Port Shepstone...................... 1d. *S. mucronata* subsp. *woodii* (Figure 1.7–1.9)

Salix mucronata *Thunb.,* Prodromus plantarum capensium 6 (1794); Willd. 4: 685 (1806); Thunb. : 31 (1807); Burtt Davy: 70 (1922) p.p.

(a) subsp. **mucronata**

Type: No type designated by Thunberg, single specimen in herb. Thunb. annotated *'S mucronata'* in his hand, *Thunberg* (sheet 23065, UPS, lecto., here designated; microfiche in PRE!).

S. subserrata Willd.: 671 (1806); Milne-Redhead: 474 (1936); Maire: 50, fig. 1129 (1961); Friedrich-Holzhammer: 14 (1967). Type: Egypt, near Cairo, Bulak, no collector (sheet 18137, B-WILLD; microfiche in PRE!).

S. aegyptica sensu Thunb.: 30 (1807), non Willd. (1806). Syntypes: Cape Province, near rivers at Roodesand, Sept.–Oct., *Thunberg s.n.* (sheets 22885, 22886, 22887, UPS; microfiche in PRE!).

S. safsaf Forssk. ex Trautv.: 6, t. 2 (1836); Forssk.: 76 (1775), as *S. safsaf baelledi,* nom. nud.; Anderss.: 196 (1868); Boiss.: 1183 (1897); Skan: 318 (1917); Burtt Davy: 432 (1932) (may refer to subsp. *wilmsii* ?). Type: Egypt, *Herb. Sieber* (LE, holo.; K, iso. fide Wilmot-Dear in litt.).

The unusual distribution of subsp. *mucronata,* which occurs in northern SWA/Namibia and in the south-western Cape, suggests that it may once have occurred in the intervening area, and that it has since died out there due to the drying up of perennial rivers in much of SWA/Namibia and Namaqualand. There is no noticeable difference between the SWA-/Namibian and Cape populations that might justify describing a new subspecies. Subsp. *mucronata* is widely distributed in Africa, entering the area under consideration also in the northern Transvaal, with one record from the eastern Transvaal. Figures 1.1–1.3 & 2A.

Within the subspecies as a whole there is a great range of variation, from specimens with glabrous branches and entire glabrous lanceolate leaves, to (in various combinations) broadly elliptic leaves with regularly to irregularly serrate margins, and slender or stout stems with dense canescence. None of the specimens from our area have stipules, though they do occur in the subspecies elsewhere in Africa.

Burtt Davy (1922) seems to have had a mixed concept of *S. mucronata.* His *S. mucronata* var. *mucronata* comprises elements of both subsp. *mucronata* (as delimited here) and of subsp. *capensis.* The range of distribution given on Burtt Davy's map includes that of both subspecies, while the synonyms cited comprise *S. aegyptica* Thunb. *(S. mucronata* subsp. *mucronata), 'S. capensis* auct. non Thunb.' , and *S. mucronata* var. *integra* (placed here under 'taxa insufficiently known'). His illustrations of the leaves are clearly those of *S. mucronata* subsp. *mucronata.* Burtt Davy therefore probably had specimens of both subsp. *mucronata* and subsp. *capensis* in mind when delimiting his *S. mucronata* var. *mucronata.*

Vouchers: *Hemm 452* (J); *Leistner, Oliver, Steenkamp & Vorster 110*; *Marloth 4283, 11843*; *Merxmüller & Giess 30494*; *Van Wyk, Retief & Herman 6737.*

(b) subsp. **hirsuta** *(Thunb.) Immelman,* comb. nov.

Salix hirsuta Thunb., Prodromus plantarum capensium 6 (1794); Thunb.: 31 (1807); Willd.: 695 (1806); Fries: 120 (1856); Krauss: 88 (1844); Skan: 579 (1912); Adamson & Salter: 311 (1950). *S. capensis* var. *hirsuta* (Thunb.) Anderss.: 14 (1867); Anderss.: 198 (1868); Sim: 329 (1907). Type: No type designated by Thunberg, single specimen in herb. Thunb. annotated *'S. hirsuta'* (sheet 23028, UPS, lecto., here designated; microfiche in PRE!). Figures 1.4 & 2B.

Vouchers: *Boucher 1985*; *Hanekom 1272*; *Hugo 746*; *Van Jaarsveld 4496.*

(c) subsp. **capensis** *(Thunb.) Immelman,* comb. nov.

Salix capensis Thunb., Flora capensis 31 (1807); Harvey: 347 (1838); Anderss.: 197 (1868) excl. vars. *mucronata, hirsuta*; Sim: 328, t. 146 (1907); Skan: 576 (1912) excl. var. *mucronata* et syn. *S. aegyptica*; Marloth: 130, fig. 73 (1913); Burtt Davy: 69 (1922); Burtt Davy: 432 (1932); Friedrich-Holzhammer: 14 (1967); Jacot Guillarmod: 161 (1971). Syntypes: Cape Province, near rivers in mountains near Hantam, *Thunberg s.n.,* (sheets 22958, 22959, 22960, UPS, microfiche in PRE!).

S. gariepina Burch.: 317, t. 6 (1822); Pappe: 35 (1862); Burtt Davy: 338 (1921). *S. capensis* var. *gariepina* (Burch.) Anderss.: 13 (1867); Anderss.: 197 (1868); Sim: 328 (1907); Skan: 576 (1912); Burtt Davy: 432 (1932). Type: Cape Province, Prieska, banks of Orange River, *Burchell 1637* (K!).

S. crateradenia Seemen: 9 (1899); Skan: 578 (1912). Type: Botswana, *Passarge 41 of 1896* (not located).

S. mucronata var. *mucronata* sensu Burtt Davy p.p. (excl. eastern element): 71 (1922). *S. mucronata* var. *caffra* Burtt Davy: 71 (1922). Isotypes: Cape Province, Eastern Districts, *Cooper 48* (BM!, K!).

Burtt Davy's concept of *S. capensis* is narrower than that adopted here for subsp. *capensis,* and I include taxa he accepts as separate. These are *S. crateradenia* from the northern Cape and *S. capensis* var. *caffra* from the eastern Cape. *S. capensis var. integra,* possibly from the eastern Cape, may also belong here but is mentioned under 'taxa insufficiently known' below. *S. mucronata* var. *mucronata* sensu Burtt Davy pro parte, excluding those specimens from the southern and eastern Cape, must also be included. Figures 1.5, 1.6; 2C.

The type of *S. crateradenia* (from the northern Cape) has not been located but, judging from Seemen's description, it is almost certainly *S. mucronata* subsp. *capensis.* He commented that it is close to *S. capensis,* but distinguished it by its well defined style

FIGURE 1. — 1–3, *Salix mucronata* subsp. *mucronata,* summer leaves. 1, Botswana, Chobe River, *Miller B946*; 2, SW Cape, Eerste River, *Boucher 3509*; 3, N Transvaal, Tate Vondo Reserve, *Hemm 452.* 4, *S. mucronata* subsp. *hirsuta,* summer leaf, W Cape, Cederberg, Uitkyk Pass, *Goldblatt 3278.* 5–6, *S. mucronata* subsp. *capensis,* summer leaves. 5, Orange Free State, Willem Pretorius Reserve, *Bourquin 888*; 6, N Cape, Barkley West, *Hafstrom H. 961.* 7–8, *S. mucronata* subsp. *woodii,* summer leaves. 7, Natal, Vants Drift, *Letty 486 sub Codd s.n.*; 8, Transvaal, Pienaars River, *Repton 435.* 9, intermediate between subsp. *woodii* and subsp. *wilmsii* ?, summer leaf, Transvaal, Krugersdorp, near Skeerpoort River, *Codd 10096.* 10–12, *Salix mucronata* subsp. *wilmsii,* summer leaves. 10, Transvaal, Lydenburg, Lowveld Botanic Garden, *Buitendag 997*; 11, Transvaal, Kruger National Park, Sigaas, *Van der Schijff 357*; 12, Transvaal, Kruger National Park, near Punda Maria, *Codd 5558.* 13, *S. babylonica,* summer leaf, Cape, near Cape Town, *Ecklon 713.* All in PRE, × 1.

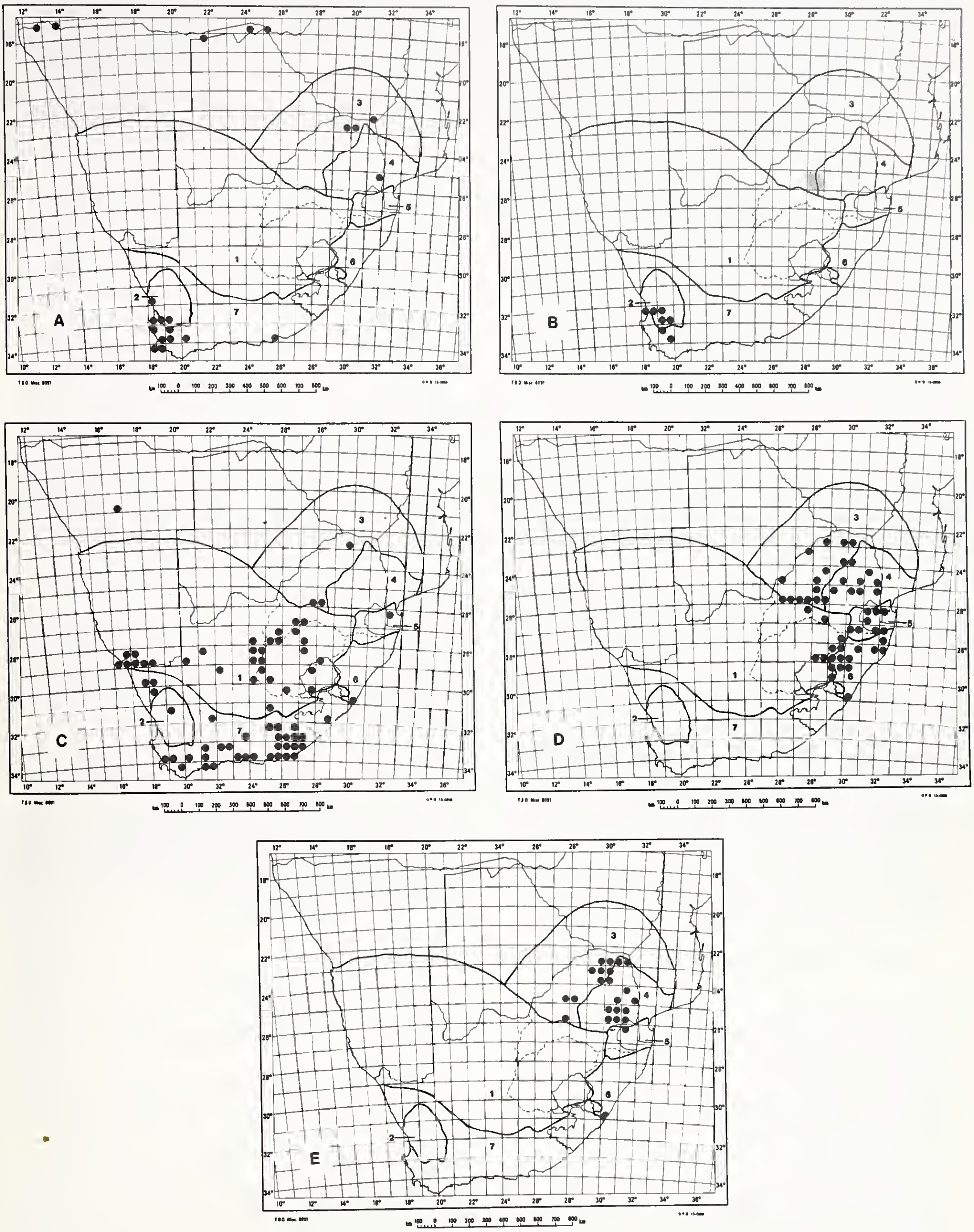

FIGURE 2.— A, *Salix mucronata* subsp. *mucronata*; B, *S. mucronata* subsp. *hirsuta*; C, *S. mucronata* subsp. *capensis*; D, *S. mucronata* subsp. *woodii;* E, *S. mucronata* subsp. *wilmsii*. 1, Orange River drainage basin; 2, Olifants River (Cape) drainage basin; 3, Limpopo River drainage basin; 4, Olifants River (Transvaal) drainage basin; 5, Maputo River drainage basin; 6, Natal rivers; 7, Cape rivers.

and the entire glands in the female flower. Styles have not been found to vary significantly in this study, and the variation in glands was found to be considerable, without any discrete ranges of variation. Burtt Davy states that the species comes from the headwaters of the Kuruman River, which is in the northern Cape, and is a tributary of the Orange River. A population of *Salix* has been found at this approximate locality by Mr A. Gubb, of the McGregor Museum, Kimberley, who states that he does not consider it to differ from *S. mucronata* subsp. *capensis* (pers. comm.).

Some specimens which might be intermediate between subsp. *capensis* and subsp. *woodii* have been seen. These are *Green 88, Leendertz 3752, Muller 1053* and *Sutton 884* (all at PRE). These occur near the boundaries of the two subspecies, both between the Orange and Limpopo drainage basins and the Orange River drainage basin and the Natal rivers.

Vouchers: *Hafstrom H 961*; *Merxmüller 2270*; *Moffett 627*; *Oliver 3121*; *Van der Westhuizen 44/78*.

(d) subsp. **woodii** *(Seemen) Immelman*, comb. nov.

Salix woodii Seemen in Botanische Jahrbücher 21 Beiblätter 53 (1896); Wood: 121 (1907); Skan: 577 (1912); Bews: 79 (1921); Burtt Davy: 40 (1921); Burtt Davy: 432 (1932); Jacot Guillarmod: 161 (1971); Compton: 172 (1976). Type: Natal, Tugela, near Colenso, *Wood 4970* (not found).

For a discussion of specimens intermediate between this subspecies and subsp. *capensis,* see under that subspecies. It also appears to grade into subsp. *wilmsii.*

Although the type has not been found, the detailed description allows it to be confidently identified as this subspecies. The leaves are said by Seemen to be 90 × 11 mm, with the margin having small sharp teeth, and the shape narrowly lanceolate to linear, which can only be subsp. *woodii.* The fact that the type comes from Natal, from the Tugela River near Colenso, confirms this identification. Figures 1.7–1.9 & 2D.

Vouchers: *Acocks 10120*; *Codd 10095*; *Duggan & Henderson 24*; *Killick & Marais 2130*; *Letty 481*; *Rogers 2736* (GRA).

(e) subsp. **wilmsii** *(Seemen) Immelman*, comb. nov.

S. wilmsii Seemen in Botanische Jahrbücher 27 Beiblätter 64: 9 (1900); Burtt Davy: 40 (1921); Burtt Davy: 432 (1932). *S. woodii* var. *wilmsii* (Seemen) Skan: 578 (1912). Type: Transvaal, Lydenburg, *Wilms F.S.A. 1350* (PRE, lecto., here designated!; BOL!).

S. wilmsii × *safsaf,* Burtt Davy: 432 (1932). Type: Transvaal, Lydenburg, Grootfontein River, foot of Burgers Pass, *Davy H 1559* (PRE!). Burtt Davy also cites: Transvaal, Barberton, *Pole Evans H 2965* (PRE!), and queries whether it is the reciprocal cross.

S. wilmsii × *woodii,* Burtt Davy: 432 (1932). Isotypes: Transvaal, Barberton, *Galpin 1278* (GRA!, PRE!).

Specimens of this subspecies have been seen which are very close to subsp. *mucronata,* e.g. *Hardy 401* and *Hemm 452.* In its typical form, subsp. *wilmsii* is easily distinguishable, but it may approach subsp. *woodii* and subsp. *mucronata* in appearance. Only further research can establish whether the taxon is simply very variable or whether it has undergone introgressive hybridization with these other subspecies. As mentioned in the Discussion, subsp. *wilmsii* itself may also be a hybrid between subsp. *woodii* and subsp. *mucronata.* In its ‘pure’ form, subsp. *wilmsii* has stout, densely canescent twigs and large, broadly lanceolate, entire leaves, which are densely grey-canescent when young. Figures 1.10–1.12 & 2E.

Vouchers: *De Winter 7685*; *Gerstner 5492*; *Hardy 957*; *Prior 33*; *Theron 3569.*

Taxa insufficiently known

S. mucronata Thunb. var. *integra* Burtt Davy in Journal of Ecology 10: 70 (1922). Type: Cape Province, Camdeboo, on the flats and at the river near the Camdeboosberg, 2000–3000 ft, *Drège s.n.* (K!, S!). The Stockholm specimen is *S. mucronata* subsp. *capensis* but the one from Kew is subsp. *hirsuta,* with large entire leaves and dense silvery pubescence on the young leaves and twigs. No other specimen resembling this has been seen from the area, and it is possible that the Kew specimen has been mislabelled. Drège did collect at the Olifants River, where subsp. *hirsuta* occurs.

S. woodii var. *grandifolia* Burtt Davy, Flowering Plants and Ferns of the Transvaal 2: 432 (1832), nom. nud. Specimens cited: *Davy 10614*; *Legat H 4331*; *Robertson 1474* (none of these found). Burtt Davy speculates whether this is not a hybrid between *S. woodii* and *S. wilmsii.*

S. woodii Seemen × *safsaf* Forssk. ex Trautv.?, Burtt Davy, Flowering Plants and Ferns of the Transvaal 2: 432 (1932). Type: Transvaal, Louis Trichardt, 3100 ft, *Rogers 21690* (not found). From the description this could be subsp. *woodii.*

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Bothalia 17,2: 179–190 (1987)

Notes on African plants

VARIOUS AUTHORS

ACAROSPORACEAE

A NEW YELLOW *ACAROSPORA* (LICHENES) FROM THE WATERBERG, SOUTH WEST AFRICA/NAMIBIA

Acarospora elegans *Brusse* sp. nov., thallo ut in *A. oxytona* (Ach.) Massal. sed excipulo tenuiore (5–10 µm), et ascosporis latioribus.

Thallus citrinus, crustosus et effiguratus, saxicola, usque ad 20 mm diametro. *Lobi* marginales usque ad 2,5 mm longi, 0,3–1,0 mm lati. *Areolae* irregulares, 0,2–1,0 mm diametro, sessiles vel subpeltatae. *Fissurae* 0,1–0,2 mm latae, 0,2–1,0 mm profundae. *Superficies* opaca, laevis vel undulata, plana vel convexa, citrina. *Cortex superior* 25–45 µm crassus (in lateribus et in pagina inferior, 10–15 µm crassus), paraplectenchymatus, cellulis 3–8,5 µm diametro. *Stratum gonidiale* 60–80 µm crassum, algis *Trebouxiis*, 5–15 µm diametro. *Medulla* alba, 70–300 µm crassa. *Pagina inferior* pallida vel brunnescens. *Apothecia* usque ad 1,5 mm diametro, emergentia vel sessilia; pagina hymenii pallida. *Excipulum thallinum* in lateribus circa 120 µm crassum. *Excipulum hyalinum,* J−, periclinate prosoplectenchymatum, 5–10 µm crassum, sed crassius ad paginam. *Hypothecium* 15–50 µm crassum, hyalinum, J+ caeruleum. *Hymenium* hyalinum, 80–90 µm altum, J+ caeruleum. *Paraphyses* fere simplices vel anastomosantes, in gelatina arcte inclusae, septatae, luminibus 1,2–1,3 µm crassis, gelatinis J+ caeruleis. *Asci* clavati vel acuminate clavati, 60–75 × 14–19 µm, parietibus incrassatis, J− (Figure 2). *Ascosporae* numerosae, hyalinae, ellipsoideae, simplices, 4–5 × 1,8–2,8 µm. *Pycnidia* globosa, hyalina, 230–290 µm profunda, 160–200 µm lata, cum algis cincta, parietibus hyalinis, circa 10 µm crassis, periclinate prosoplectenchymatis, cavitatibus convolutis. *Pycnidiosporae* hyalinae, longe ellipsoideae, 2,0–3,5 × 1,0–1,2 µm. *Thallus* acidum rhizocarpicum continens.

TYPE.—South West Africa/Namibia, 2017 (Waterberg): Waterberg campsite trial, common on S facing sandstone cliffs (–CA), *F. Brusse 4218*, 1984.03.22 (PRE, holo.; COLO, LD, iso.) Figure 1.

Thallus as in *A. oxytona*, but the exciple thinner (5–10 µm), and the ascospores broader.

Thallus yellow, effigurate-crustose, saxicole, up to 20 mm diam. (larger by confluence). *Lobes* marginal, up to 2,5 mm long, 0,3–1,0 mm broad. *Areoles* irregular, 0,2–1,0 mm across, sessile to subpeltate. *Fissures* 0,1–0,2 mm wide, 0,2–1,0 mm deep. *Upper surface* opaque, smooth to undulate, plane to convex, yellow. *Upper cortex* 25–45 µm thick (10–15 µm thick on sides and lower surface), paraplectenchymatous, cells 3–8,5 µm diam. *Algal layer* 60–80 µm thick; algae *Trebouxia*, 5–15 µm diam. *Medulla* white, 70–300 µm thick. *Lower surface* pale to brownish. *Apothecia* up to 1,5 mm diam., emergent to sessile; hymenial surface pale. *Thalline exciple* about 120 µm thick on sides. *Exciple* hyaline, J−, periclinally prosoplectenchymatous, 5–10 µm thick, but thicker at surface. *Hypothecium* 15–50 µm thick, hyaline, J+ blue. *Hymenium* hyaline, 80–90 µm high, J+ blue. *Paraphyses* largely simple, but often anastomosed, strongly gelled, septate, lumens 1,2–1,3 µm thick, gel J+ blue. *Asci* clavate or acuminate-clavate, 60–75 × 14–19 µm, walls thick (particularly at apex), J− (Figure 2). *Ascospores* numerous, hyaline, ellipsoid, simple, 4–5 × 1,8–2,8 µm. *Pycnidia* globose, hyaline, 230–290 µm deep, 160–200 µm wide, surrounded by algae; walls hyaline, about 10 µm thick, periclinally prosoplectenchymatous; cavity convoluted. *Pycnidiospores* hyaline, long-ellipsoid, 2,0–3,5 × 1,0–1,2 µm. *Chemistry*: Rhizocarpic acid in the cortex.

This new species resembles *Acarospora oxytona* (Ach.) Massal. in thallus habit and lobe anatomy, but differs in the thickness of the exciple and in the ascospore size. The exciple is only 5–10 µm thick in *A. elegans*, whereas it is 30–50 µm thick in *A. oxytona* (Magnusson 1929). The ascospores are somewhat broader in the former species, reaching 2,8 µm in equatorial diameter, and are ellipsoid. *A. oxytona* ascospores only reach 2 µm in equatorial diameter, being narrowly ellipsoid. The hypothecium of *A. oxytona* also tends to be thicker and is darker blue in Lugol's iodine solution as well.

The lobe surfaces (Figure 3) of *A. elegans* are never scabrous as they often are in *A. oxytona* (Figure 4), however, and the latter is often an alpine lichen in the northern hemisphere. *A. elegans* is abundant on south facing vertical or near vertical sandstone cliffs in the Waterberg of South West

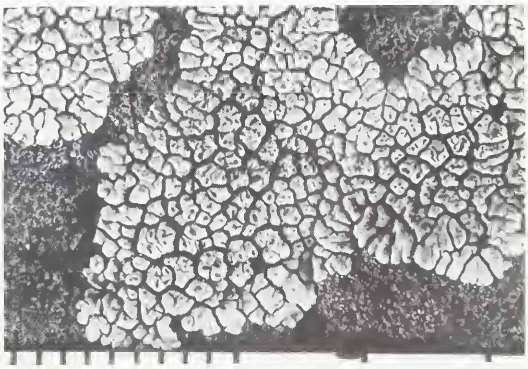

FIGURE 1.—*Acarospora elegans* Brusse, habit. *F. Brusse 4218*, holotype. Scale in mm.

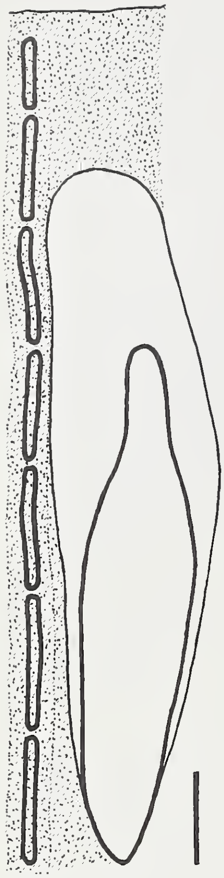

FIGURE 2.—*Acarospora elegans* Brusse, ascus and paraphysis. *F. Brusse 4218,* holotype. Bar = 10 µm.

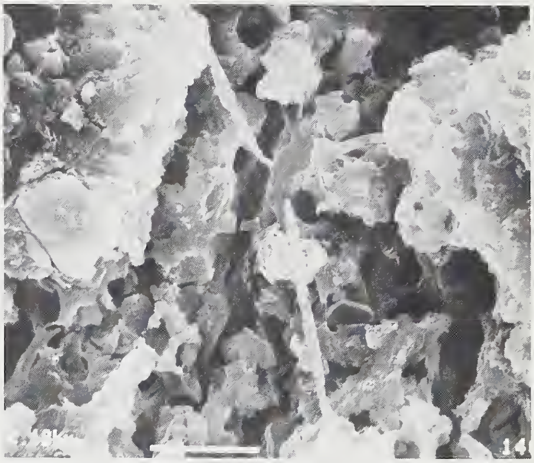

FIGURE 4.—*Acarospora oxytona* (Ach.) Massal., scanning electron micrograph of upper surface. *Hora s.n.* (Arnold Lichen Exsiccati 1159a). Bar = 9,2 µm.

Africa/Namibia. A photograph of this lichen from a distance, is given by McDonald (1986), where the yellow areas on the rocks are mainly or wholly this new lichen. This is an unusually shaded place for an *Acarospora*, particularly a yellow one, which usually competes best in dryer places. In this regard, the new species is similar to *A. oxytona*, because the latter also grows on steep cliff faces and under rock overhangs (Magnusson 1929; Santesson 1984).

The cortical chemistry is usual for a yellow *Acarospora*, containing the bright yellow pigment rhizocarpic acid. The medulla contains acetone extractable substances which show up as faint spots on TLC plates (Culberson 1972; Culberson & Johnson 1982) in longwave UV light. These substances are identical to those found in *A. oxytona*, the extract of which was co-chromatographed with that of *A. elegans*. However, *A. oxytona* contains acaranoic and acarenoic acids (Sarma & Huneck 1968; Follmann & Huneck 1971; Huneck & Hofle 1980) in addition, which could not be detected in *A. elegans*.

Several other effigurate yellow *Acarosporae* are known from southern Africa (Magnusson 1933), but these all have cylindrical ascospores, which are only 1 or 1,5 µm wide. Two of these (*A. austroafricana* (Zahlbr.) H. Magn. and *A. finckei* Zahlbr.) are Namib Desert lichens, known from schistose rocks. The remaining species, *A. calviniensis* Magn., is a thinner lichen, reaching 0,25 mm in thickness, and with areoles only up to 0,5 mm across. The pycnidiospores of the last lichen are also shorter, reaching 1,7 µm long.

A. elegans is presently known only from the Waterberg in South West Africa/Namibia, on steep sandstone rock faces with a southern aspect.

Specimens of *Acarospora oxytona* (Ach.) Massal. examined:

CZECHOSLOVAKIA.—4916: An Gneissfelsen bei Rossatz [Rossitz] im Donauthale, *Baumgartner s.n.*, 1898 (*Arnold, Lichenes Exsiccati 1159c*; *PRE CH3216*). 5014: An Quarzfelsen der Scharka bei Prag, *Hora s.n.*, Frühjahr 1886 (*Arnold, Lichenes Exsiccati 1159a*; *PRE CH3213)*.

RUMANIA.—4422: Hungaria austro-orientalis (Banatus), in rupibus calcareis ad Mehadiam, *Lojka s.n. (Flora Exsiccata Austro-Hungarica 1951*; *PRE CH606)*. 4522: An senkrechten Quarztrachytwänden unter dem Gipfel des Berges Treszkovácz bei Savinicza an der unteren Donau, Comitat Krasso-Szörény [Caras-Severin] in Ungarn, *Lojka s.n.*, 25. April 1886 *Arnold Lichen Exsiccati 1159b*; *PRE CH3214)*.

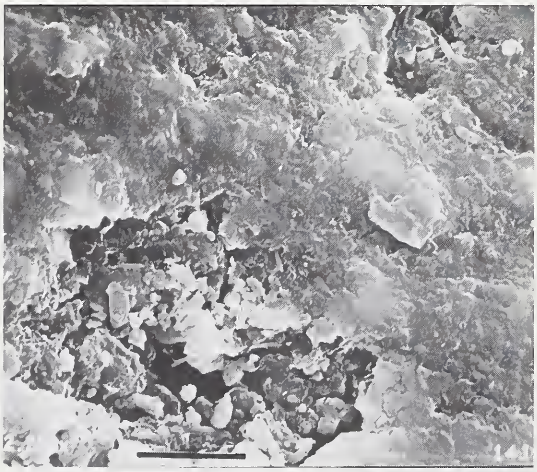

FIGURE 3.—*Acarospora elegans* Brusse, scanning electron micrograph of upper surface. *F. Brusse 4218,* holotype. Bar = 8,9 µm.

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F. BRUSSE*

* Botanical Research Institute, Department of Agriculture and Water Supply, Private Bag X101, Pretoria 0001.

CUCURBITACEAE

ORTHOGRAPHIC AMBIGUITY CLARIFIED

Acanthosicyos Welw. ex Hook. f. was published in Benth. & Hook.f., *Genera plantarum* 1: 824 in September 1867 and although Welwitsch described the genus it only appeared in *Transactions of the Linnean Society* 27:30, two years later.

The type species, *A. horrida* was published as a descriptio generico-specifica in accordance with Art. 42.1 (Sydney Code) but this was an orthographic error. Art. 75 in Ex. 1 of recommendation 75A.1 is quite specific that the classical gender of -sicyos is masculine and this should be retained in the epithet as *A. horridus*.

The name has been published correctly both in Index Kewensis and by Jeffrey (1962) in *Kew Bulletin* 15,3:340; but it has been consistently misused in the South African literature.

B.D. SCHRIRE*

* Botanical Research Institute, Private Bag X101, Pretoria 0001. Presently: SALO, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AE, England.

FABACEAE

A NEW SPECIES OF *RHYNCHOSIA* FROM THE RICHTERSVELD

Rhynchosia emarginata *Germishuizen*, sp. nov., *R. candidae* affinis sed floribus longioribus, foliolis emarginatis, infra punctis luteis glandularibus differt.

TYPE.—Cape Province, 2816 (Oranjemund): Richtersveld, Numees, west side of ridge north of Numees Camp (–BD), *McDonald 703* (PRE, holo.; STE–U, iso.). Figure 5.

Robust, erect, much branched woody shrub up to 0,75 m tall. Branches and branchlets densely white adpressed tomentose, interspersed with conspicuous yellow resinous glands; old stems glabrescent with bark flaking off in irregular pieces. *Stipules* free, adnate to base of petiole, up to 3,5 mm long, white adpressed tomentose on the outside, glabrous inside. *Leaves* trifoliolate; leaflets broadly obovate, (4–) 5–11,2 (–12) × 3,5–8 (–9) mm, emarginate, obtuse at base, with dense, adpressed strigose white hairs on the upper surface, sparsely white adpressed strigose mainly along the veins interspersed with conspicuous yellow resinous gland dots on lower surface. *Petiole* up to 11,5 mm long, white adpressed tomentose, interspersed with yellow resinous glands. *Inflorescences* axillary, few-flowered racemes up to 65 mm long, including a 25–45 mm long peduncle, white adpressed hairy, interspersed with yellow resinous glands; bracts caducous. *Flowers* up to 17 mm long. *Calyx* 8 mm long, 5-lobed; lobes unequal, 4–5 mm long, the upper pair connate, white adpressed strigose, interspersed with yellow resinous glands. *Standard* yellow with conspicuous purple veins on the outside, obovate, 15 × 10 mm, eared at the base, glabrous. *Wing petals* yellow, oblong, eared, 13 × 3 mm, sculpturing absent. *Keel blades* up to 17 mm long, yellow, purple at the apex, shallowly pocketed. *Stamens* up to 17 mm long, 9 fused into a staminal sheath and the 1 vexillar stamen free; anthers uniform, 1 mm long. *Ovary* ovate, strigose. *Style* up to 18 mm long, filiform, slightly thickened and incurved in the upper third; stigma capitate, hairy. *Fruit* a rimmed, flat, slightly falcate 2-seeded pod, 30 × 8 mm, straw-coloured, often streaked with purple, densely tomentose when young becoming sparsely tomentose, interspersed with yellow resinous glands later.

CAPE.—2816 (Oranjemund): Richtersveld, Numees (–BD), *Jürgens 52; Jürgens 10114; McDonald 753;* west side of ridge

FIGURE 5.—Holotype of *Rhynchosia emarginata* Germishuizen.

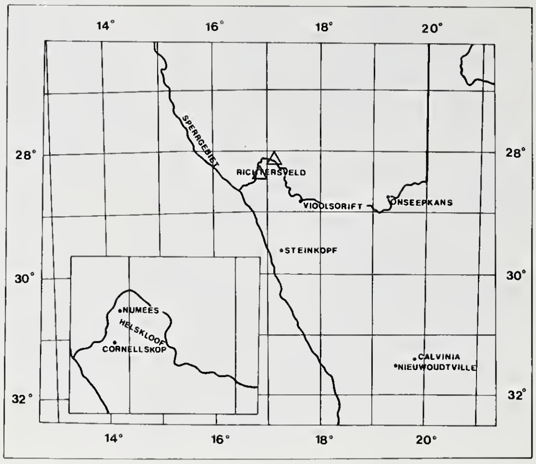

FIGURE 6.—Distribution map of *Rhynchosia emarginata* Germishuizen.

north of Numees Camp (–BD), *McDonald 703*. 2817 (Vioolsdrif): head of Helskloof, Hottentotsparadysberg (–AA), *Thompson & Le Roux 146*.

R. emarginata is found in the Richtersveld in north-western Cape Province just south of the Orange River (Figure 6) growing amongst rocks on steep slopes or in dry streambeds. The first record of the species in the PRE Herbarium was collected by Thompson and Le Roux during August 1977 from Helskloof. It flowers during August and September. All the material cited above was incorrectly identified as *Rhynchosia schlechteri* Bak.f.and *R. viscidula* Steud. *R. emarginata* can be distinguished from the two above species by having emarginate obovate leaflets adpressed hairy on the undersurface, interspersed with conspicuous yellow resinous glands and the absence of yellow glandular hairs with bulbous bases on the stems, petioles and undersurface of the leaves that are readily found on the above-mentioned species. In appearance, *R. emarginata* is closest to *R. emarginata* but it differs in having longer flowers, emarginate leaflets and yellow resinous glands on the undersurface of the leaflets.

ACKNOWLEDGEMENTS

I would like to thank Dr H.F. Glen for translating the diagnosis into Latin and Mr E.G.H. Oliver of the Stellenbosch Herbarium for sending their material of this species on loan and Mrs W. Roux for drawing the map.

G. GERMISHUIZEN*

* Botanical Research Institute, Private Bag X101, Pretoria 0001.

LICHENES

PSATHYROPHLYCTIS, A NEW LICHEN GENUS FROM SOUTHERN AFRICA

Psathyrophlyctis serpentaria *Brusse*, gen. et sp. nov.

Thallus crustosus, terricola, usque ad 60 mm diametro, 0,5–1,0 mm crassus, olivaceus, omnino in sorediis dissolutus. *Soredia* 20–40 μm diametro. *Algae* chlorococcaleae, 4,5–10 μm diametro. *Apothecia* lecideina, atra, convexa, laeves vel verrucata, usque ad 1,5 mm diametro. *Excipulum* stramineum vel pallide brunneum, radiatim et anticlinate scleroplectenchymatum (Figures 8e & 9), 60–120 μm crassum. *Hypothecium* brunneum, collenplectenchymatum (Figure 8a), 30–45 μm crassum, cellulis 4–8 μm diametro. *Hymenium* hyalinum vel stramineum, circa 100 μm altum, interruptum. *Asci* clavati vel late clavati, cum tholis et parietibus externis J+ caeruleis (Figure 10). *Ascosporae* unicae vel binae, hyalinae, muriformes, septis incrassatis, J–, 35–45 × 17–18,5 μm, loculis 10–14-seriatis, locellis 4–5-seriatis. *Pycnidia* non visa. *Thallus* materiam ignotam continens (Table 1).

TYPE.—Cape Province, 3321 (Ladismith): 17 km N of Riversdale, Garcia's Pass, SW side of Ka-

FIGURE 7.—*Psathyrophlyctis serpentaria* Brusse, habit. *F. Brusse 3612,* holotype. Scale in mm.

reekop, in the Langeberg, on soil near rock on a steep S slope (–CC), *F. Brusse 3612*, 1981.05.10 (PRE, holo.). Figure 7.

Thallus crustose, on soil, up to 60 mm across, 0,5–1,0 mm thick, olive green, completely dissolved into soredia. *Soredia* 20–40 µm diam. *Algae* chlorococcalean, 4,5–10 µm diam. *Apothecia* lecideine, black, convex, smooth to warted, up to 1,5 mm across. *Excipulum* stramineous or pale brown (some of the interstitial spaces are dark brown and are indicated in Figure 8 by heavy lines), radiately and anticlinally scleroplectenchymatous (Figures 8e & 9), 60–120 µm thick. *Hypothecium* brown, collenplectenchymatous (Figure 8a), 30–45 µm thick, cells 4–8µm diam. *Hymenium* hyaline to stramineous, about 100 µm high, interrupted by areas of sterile hymenium with more branched paraphyses and more deeply brown colour. *Asci* clavate to broadly clavate (mature asci), one- or two-spored, tholus and outer wall J+ blue (Figure 10). *Ascospores* hyaline, muriform, septa thickened but J–, 35–45 × 17–18,5 µm, 10–14-loculate, 4–5-locellate. *Pycnidia* not seen. *Chemistry*: an unknown substance present (Table 1), which is invisible in daylight and longwave ultra-violet light.

TABLE 1.—Thin-layer chromatographic data for the unknown substance in *Psathyrophlyctis serpentaria* (Culberson 1972; Culberson & Johnson 1982)

	A	B	C
R_f class	6	5	6
R_f value	70/54,80	44/36,76	57/33,67

A = benzene:dioxane:glacial acetic acid (180:45:5 by volume)
B = n-hexane:methyl *tert*.-butyl ether:formic acid (140:72:18 by volume)
C = toluene:glacial acetic acid (200:30 by volume)

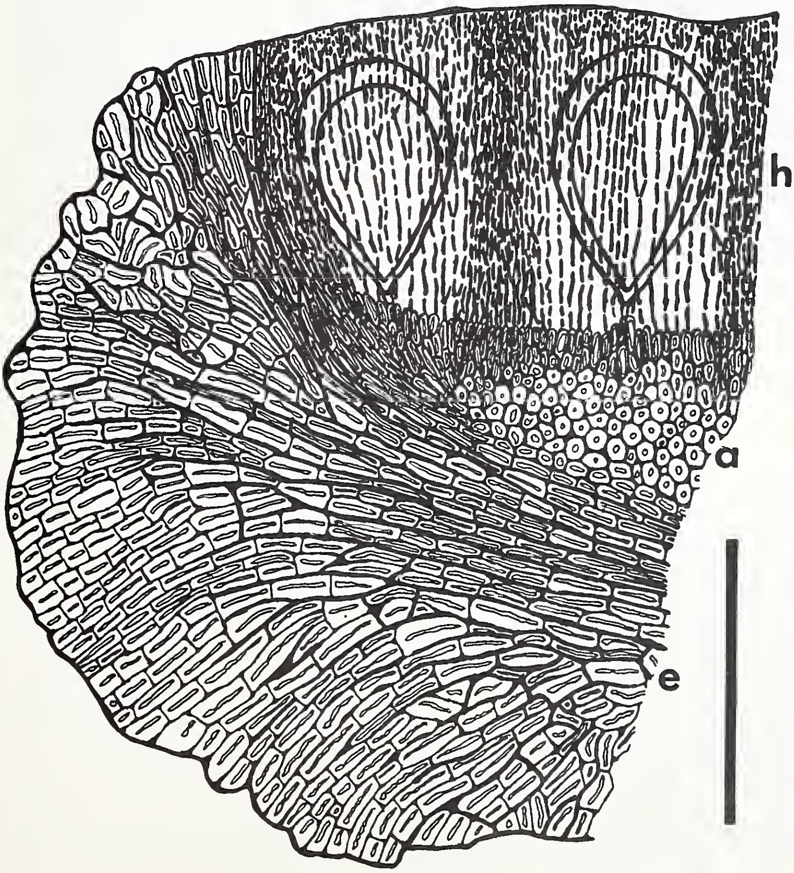

FIGURE 8.—*Psathyrophlyctis serpentaria* Brusse, section of apothecium edge, showing exciple (e), hypothecium (a), and hymenium (h). *F. Brusse 3612*, holotype. Bar = 100 µm.

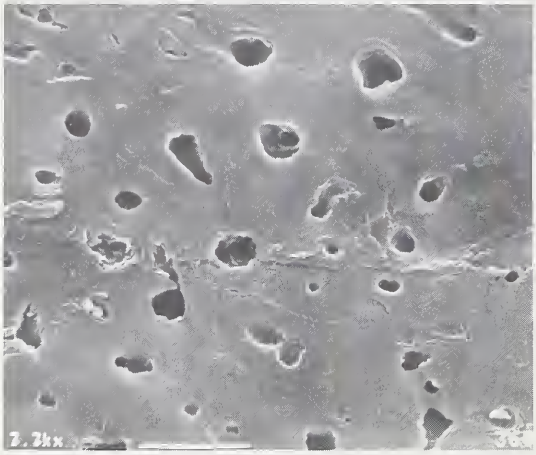

FIGURE 9.—*Psathyrophlyctis serpentaria* Brusse, scanning electron micrograph of the exciple, showing its sclerotized tissue. *F. Brusse 3612,* holotype. Bar = 6 μm.

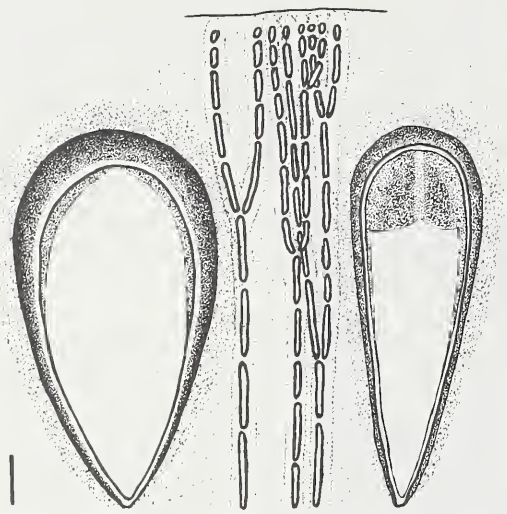

FIGURE 10.—*Psathyrophlyctis serpentaria* Brusse, asci and paraphyses. The ascus on the right is immature. *F. Brusse 3612,* holotype. Bar = 10 μm.

This new lichen superficially resembles a *Phlyctis*, because of the J+ strongly blue, thick outer wall, and hyaline muriform spores (Poelt 1969). However, the ascospores of *Phlyctis* are thin-walled, and the tholus is J− and not well developed (Poelt 1973). The exciple is also truly paraplectenchymatous, whereas this lichen only appears to be paraplectenchymatous, due to the dark brown interstices. The exciple of *Psathyrophlyctis* is in fact scleroplectenchymatous, as can be seen from a scanning electron micrograph of a section (Figure 9), and also from sections in lactophenol cotton-blue stain, under the light microscope (Figure 8).

The interrupted hymenium, and the sclerotized exciple tissue reminds one of certain genera in the Graphidaceae, such as *Medusulina*, but here the often elongated apothecia are seated in stromata and the interruptions are of stromal tissue, not sterile hymenial tissue. The ascospores of *Medusulina* are thick-walled as well, but as is typical of this family, the walls become brown and sometimes even blue-brown in Lugol's iodine solution (Redinger 1933). The paraphyses of the Graphidaceae are generally simple or only sparingly branched and *Trentepohlia* is a common photobiont.

Psathyrophlyctis may be related to *Phlyctidia* Müll. Arg. ex Zahlbr. (1907), but the ascospores are only transversely septate in the latter (Zahlbruckner 1907, 1926).

As stated in the description, the thallus of this lichen is completely sorediate and is quite thick, and resembles the thallus of *Lecidea crassa* Nees ex Stiz. somewhat. However the thallus of *Lecidea crassa* is yellow, due to usnic acid, and also contains a series of terpenes. *Psathyrophlyctis serpentaria* has an olive green thallus, and looks yellowish in places under a dissecting microscope, but no yellow pigments were detected in an acetone extract of this lichen. Only two substances were detected by TLC (Culberson 1972; Culberson & Johnson 1982) in *P. serpentaria*, one was a small grey terpene spot, and the other was an evenly pale orange spot, after sulphuric acid and heat treatment. The latter substance seems to be new, and the TLC data for it is shown in Table 1.

This species is presently known only from the type locality, the seaward slopes of the Langeberg Range near Riversdale, on soil near rock. The slopes are heavily covered with fynbos vegetation, and this may explain its occurrence near rock, where some light and perhaps some fire protection may be available.

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F. BRUSSE*

* Botanical Research Institute, Department of Agriculture and Water Supply, Private Bag X101, Pretoria 0001.

LILIACEAE

NOTES ON *KNIPHOFIA*

Kniphofia bruceae *(Codd) Codd*, stat. nov.

K. praecox Bak. subsp. *bruceae* Codd in Bothalia 9: 449 (1968). Type: Cape, near Komga, *Bruce 604* (PRE, holo.).

The plant described as *K. praecox* Bak. in Saunder's *Refugium Botanicum,* t.169 (1870) came from the garden of Mr Saunders and is recorded as having been collected by Thomas Cooper at the Cape. An examination of the type specimen in K, however, led to the conclusion that the plant was of hybrid derivation. As mentioned in *Bothalia* 9: 445 (1968), it resembles specimens of unknown origin cultivated in Europe since the early part of the nineteenth century and which are preserved in several European herbaria (e.g. BM, G, L) under names such as 'Aletris uvaria', 'Tritomanthe uvaria' etc. They differ from *Kniphofia uvaria* (and related robust species such as *K. linearifolia*) in having longer and more acuminate bracts and cannot be exactly matched by specimens collected in the wild state. Similar hybrids are now in cultivation throughout the world and two forms, a summer-flowering and a winter-flowering red-hot poker, are widely grown in South Africa and are occasionally found as garden escapes.

It was further concluded that the narrow bracts were contributed by a little-known robust *Kniphofia* which has been recorded from three small disjunct areas: (a) near Komga, (b) between Plettenberg Bay and Knysna and (c) near Kouga in the Willowmore District. Because of its affinity with and possible parentage of *K. praecox*, this *Kniphofia* was described as *K. praecox* subsp. *bruceae* in 1968. However, it may be separated from *K. praecox* on the basis of several characters, for example the narrower, even more acuminate bracts, longer pedicels, the somewhat shorter perianth which tends to be constricted above the ovary, and the well exserted stamens. It is, therefore, considered that a more satisfactory treatment would be to accord separate species rank to the wild plant.

In view of its rarity and limited distribution, it may be questioned if *K. bruceae* could have been introduced to Europe before or near the beginning of the nineteenth century. Fortunately, such an introduction can be confirmed by the illustration in Jacquin's *Fragmenta* t.4 (probably 1800), reproduced in *Bothalia* 9: 381 (1968). Although entitled 'Veltheimia uvaria', it is not that species, but is an excellent match of the type of *K. bruceae* from near Komga. Note, for instance, the shape of the raceme, the drawing of a separate flower showing the constriction above the ovary and the well exserted stamens, the acuminate bracts at the base of the raceme, and the portion of an old raceme with numerous persistent pedicels, all of which are characteristic of *K. bruceae* (illustrated in *Bothalia* 9: 450, 451, 1968). Although Jacquin does not record the origin of his plant, there can be little doubt that it must have been collected by Georg Scholl, collector for the Schönbrunn Gardens, who spent from 1786 to 1799 in South Africa, accompanied during 1786 to Feb. 1787 by Franz Boos. Details of his itineraries are not known but it may be accepted that his travels took him eastwards as far as Kaffraria.

In Bothalia 9: 448 (1968), the few known specimens from the Knysna – Willowmore areas were included in *K. praecox* subsp. *praecox*. They are now considered to belong rather in *K. bruceae* and, although they differ somewhat from the Komga specimens, they also differ among themselves, and more material from these areas is desirable. Since the 1968 revision, only one additional specimen, *Comins 1552* from Kei Road, a good match of the type of *K. bruceae*, has been seen.

L.E. CODD*

* Botanical Research Institute, Private Bag X101, Pretoria 0001.

POLYGONACEAE

A NEW VARIETY OF *OXYGONUM ALATUM*

Oxygonum alatum *Burch.*, Travels in the interior of southern Africa 1: 548 (1822). Type: South Africa, Griqualand West, *Burchell 2074* (K, holo.!; PRE!).

Annual herb, up to 0,5 m tall, much branched from the base. *Stems* prostrate, semi-erect or erect, longitudinally ridged, reddish purple at the base, sparingly or densely covered with white cup-shaped or elongated scales. *Ocrea* membranous, funnel-shaped, 6–9 mm long, greenish-white, covered with cup-shaped or elongated scales, lobed; lobes triangular, ending in a red or white rigid seta, 2–3,5 mm long. *Leaves* simple, fleshy, lanceolate, ovate or rhomboid, (14–) 17–85 (–125) × (2–) 4–25 mm, entire or shallowly to deeply lobed, the lobes usually further divided, acute, narrowing and tapering to a short petiole, glabrous or covered with white cup-shaped or elongated scales especially along the midrib and margins. *Inflorescence* a long lax thyrse with fascicles of up to 4 flowers in the axils of ovate membranous bracts. *Flowers* hermaphrodite and male. *Perianth* pink or white, 5–cleft, the outer two segments keeled and mucronate, up to 7 mm long, glabrous or with a few cup-shaped or elongated scales. *Stamens* 8, inserted on the inner perianth; anthers bluish, 1 mm long; filaments white, 4 mm long, with a ring of cilia one-eigth from the base. *Styles* 3, joined for a third of their lengths; stigmas capitate. *Fruit* a nut, winged at the three angles, sometimes with small spreading prickles a third from the base, red or yellow-brown, glabrous or with a few scattered cup-shaped or elongated scales, 10–13 × 9–11 mm.

In semi-arid grassland and open woodland on red sandy soils, often locally common in disturbed places and under trees, in SWA/Namibia, Botswana, the western Transvaal and northern Cape Province.

Two varieties are recognized and are separated on the presence or absence of cup-shaped or elongated scales.

a. var. **alatum**

Oxygonum alatum Burch., Travels in the interior of southern Africa 1: 548 (1822); Meisn.: 38 (1856); Hook. f.: 14 (1880); Engl.: 6 (1888); Schinz: 57 (1896); Hiern: 902 (1900); Schinz: 870 (1901); Dinter: 58 (1909); C.H. Wr.: 460 (1912); Bak. & C.H. Wr.: 99 (1909); Burtt-Davy: 167 (1926); R.A. Grah.: 165 (1957); Tikovsky & Merxm.: 3 (1969). Type: South Africa, Griqualand West, *Burchell 2074* (K, holo.!; PRE).

O. alatum var. *incisum* Sond.: 98 (1850), *ex descr.*

O. alatum var. *integrifolium* Sond.: 98 (1850), *ex descr.*, excl. syn. *O. dregeanum* Meisn.

O. alatum var. *marlothii* Engl.: 6 (1888); C.H. Wr.: 460 (1912). Type: Cape (British Bechuanaland), Kuruman, *Marloth 1016* (BOL, iso.!; GRA!, K!, SAM!).

Only cup-shaped scales are present scattered over the whole plant. Figure 11. Distribution and ecology more or less as for the species. Figure 12.

Vouchers: *Germishuizen 2624* (PRE); *2674* (PRE, WIND); *Leistner 1366* (NBG, PRE); *Lewis 4204* (PRE, SAM, STE–U); *Maguire 2225* (BOL, NBG, PRE, WIND).

FIGURE 11.—*Oxygonum alatum* var. *alatum* (*Germishuizen 2624,* PRE). Cup-shaped scales on abaxial leaf surface, × 110.

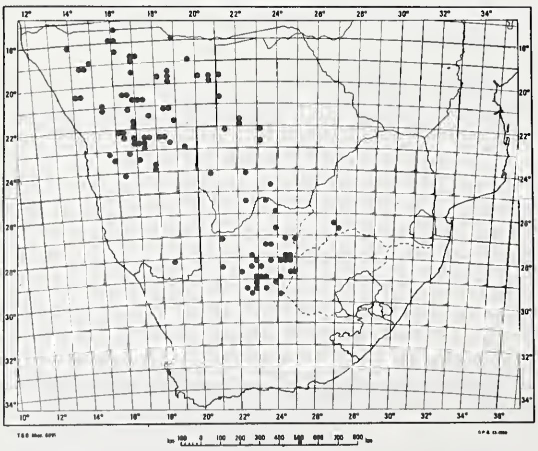

FIGURE 12.—Distribution of *Oxygonum alatum* var. *alatum* in southern Africa.

b. var. **longisquamatum** (*Germishuizen,* var. nov., a varietate typico (solum) squamis elongatis differt.

TYPE.—SWA/Namibia, near Oshandi 25 km SE of Oshikango, *R.J. Rodin 9104* (WIND, holo.). Figure 13.

The whole plant is covered with both cup-shaped and elongated scales in varying density. Figure 14.

Found in northern South West Africa/Namibia and northern Botswana. Figure 15.

SWA/NAMIBIA.—1715 (Ondangua): Ogongo Agricultural College (–CB), *E.J. van Jaarsveld 2862* (NBG). 1716 (Enana): Oshandi, 25 km SE of Oshikango (–AC), *R.J. Rodin 9104* (WIND); Oshigambo (–CC), *S. Soini s.n.* (PRE, WIND). 1920 (Tsumkwe): 6 km E of Tsumkwe (–DA), *W. Giess, J.S. Watt & J. Snyman 11024* (WIND); 16 km E of Tsumkwe (–DA), *W. Giess, J.S. Watt & J. Snyman 11171* (WIND).

BOTSWANA.—1823 (Siambusso): Molapo, 2 km NW of James Camp (–CB), *D.T. Williamson 81* (PRE). 1926 (Tsekanyani): Nata area at Nata River Delta (–CD), *J.F. Ngoni 488* (PRE). 2124 (Rakops): Maun-Rakop, 16 km W of Rakop (–AB), *H.J. van Rensburg B4099* (PRE); Kalatraverse, 12 km W of eastern boundary of Central Kalahari Game Reserve (–AC), *A.R. Kreulen 644* (PRE). 2125 (Lothlekane): Orapa (–AD), *O. Kerfoot 7752* (PRE). 2126 (Tlada Mabeli): Tlada Mabeli-Masu area, near Soa Pan (–AA), *J.F. Ngoni 308* (PRE).

The epithet *longisquamatum* refers to the elongated scales scattered over the whole plant, which can be seen with the naked eye.

FIGURE 13.—Holotype of *Oxygonum alatum* var. *longisquamatum* Germishuizen.

FIGURE 14.—*Oxygonum alatum* var. *longisquamatum* Germishuizen (*Giess 11171*, WIND). Elongated scales present on stem surface, × 230.

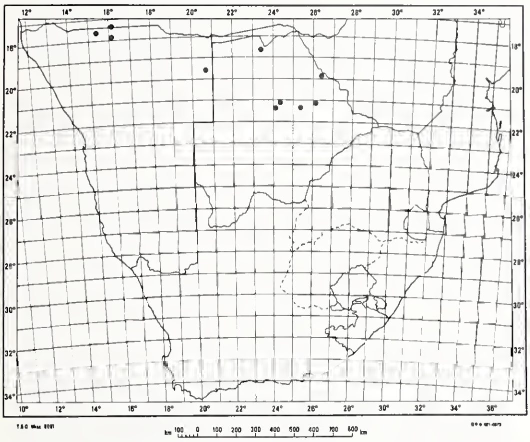

FIGURE 15.—Distribution of *Oxygonum alatum* var. *longisquamatum* in southern Africa.

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G. GERMISHUIZEN

TRAPELIACEAE

A NEW SPECIES OF *TRAPELIA* (LICHENES) FROM SOUTHERN AFRICA

Trapelia chiodectonoides *Brusse*, sp. nov.

Thallus crustosus, saxicola, cretaceus vel pallide cinereus, pannum grandem continuum circa 200 mm diametro efficiens, rimosus vel rimoso-areolatus, areolis 0,2–4,0 mm diametro, vulgo circa 1 mm diametro, laevis, 0,2–1,0 mm crassus, rimis usque ad 0,1 mm latis. *Superficies* laevis, subnitida, isidiis sorediisque destituta. *Cortex superior* 10–17 μm crassus, paraplectenchymatus, cellulis 4–8 μm diametro. *Stratum gonidiale* 35–50 μm crassum; algae ad Chlorococcales pertinentes, 5–15 μm diametro. *Medulla* alba, C+ rubra. *Apothecia* rubiginosa, usque ad 0,5 mm diametro, lecanorina sed marginibus mox fatiscentibus, dein lecideina, in maculis circularibus, 2–5 mm diametro, super areolis grandibus et pustulatis aggregata. *Excipulum thallinum* evanescens. *Excipulum* pallide porphyreum, in lateribus 20 μm crassum, infra degenerum. *Hypothecium* hyalinum, 40–100 μm crassum, cellularum isodiametrarum compactarum, 3–7 μm diametro compositum. *Hymenium* hyalinum, 90–110 μm altum, J+ pallide caeruleum. *Paraphyses* septatae, ramosae, liberae, 1,1–1,3 μm crassae. *Asci* cylindrici vel fusiformo-cylindrici, 75–100 × 15–22 μm, tholis umbonatis, J+ perpallide caeruleis, fere hyalinis (Figura 17). *Ascosporae* octonae, hyalinae, simplices, ellipsoideae, 16–21 × 8–10,5 μm. *Pycnidia* non visa. *Thallus* acidum gyrophoricum continens.

TYPE.—Natal, 2829 (Harrismith): Cathedral Peak Reserve, Doreen Falls area, near lower falls, on steep E slope, on SE face of Clarens sandstone boulder in grassland, alt. 1 680 m (–CC), *F. Brusse 4540*, 1986.01.22 (PRE, holo.; BM, LD, iso.). Figure 16.

Thallus crustose, saxicolous, ashy or chalky whitish, growing in large continuous patches up to

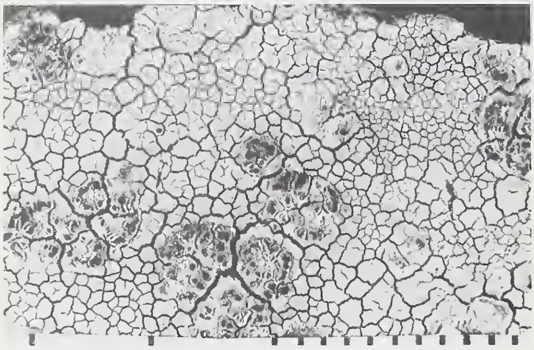

FIGURE 16.—*Trapelia chiodectonoides*, habit. *F. Brusse 4540*, isotype. Scale in mm.

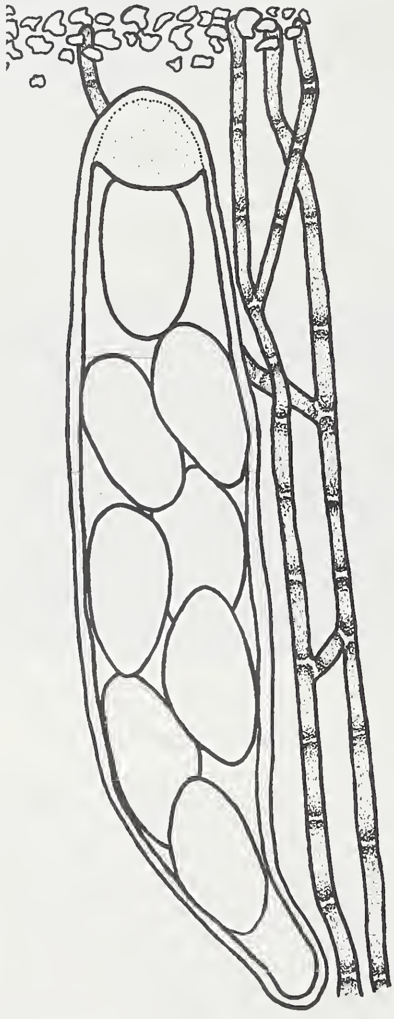

FIGURE 17.—*Trapelia chiodectonoides*, ascus and paraphyses. *F. Brusse 4540*, holotype. Bar = 10 μm.

200 mm across, rimose to rimose-areolate, areoles 0,2–4,0 mm across, commonly 1 mm across, smooth, 0,2–1,0 mm thick, cracks up to 0,1 mm wide. *Surface* smooth, subnitid, not isidiate or sorediate. *Upper cortex* 10–17 μm thick, paraplectenchymatous, cells 4–8 μm diam. *Algal layer* 35–50 μm thick; algae Chlorococcalean, 5–15 μm diam. *Medulla* white, C+ red. *Apothecia* brownish red, up to 0,5 mm diam., lecanorine but margins soon disintegrating, becoming lecideine, aggregated into circular spots, 2–5 mm across, on large pustular areoles (Figure 16). *Thalline exciple* evanescent. *Exciple* pale reddish brown, 20 μm thick on flanks, degenerate below. *Hypothecium* hyaline, 40–100 μm thick, composed of compacted isodiametric cells, 3–7 μm diam. *Hymenium* hyaline, 90–110 μm high, J+ pale blue. *Paraphyses* septate, branched, free, 1,1–1,3 μm thick. *Asci* eight-spored, cylindrical to fusiform-cylindrical, 75–100 × 15–22 μm, tholus bossed, J+ very pale blue almost hyaline (Figure 17). *Ascospores* hyaline, simple, ellipsoid, 16–21 × 8–10,5 μm. *Pycnidia* not seen. *Chemistry*: gyrophoric acid present.

Etymology: the specific epithet is derived from the Greek generic name *Chiodecton* and the Greek suffix, *-oides*, which indicates resemblance, because the aggregated apothecia superficially resemble those of some *Chiodecton* species. The apothecia of *Chiodecton* are, however, very different, being embedded in stromatic tissue, which is often sclerotic.

The apothecial habit of this new species is unique in *Trapelia*, being an unknown trait in this genus until now (Coppins & James 1984; Hertel 1969, 1970, 1977). The thallus is also strongly developed and coherent, a condition not common in this genus (Coppins & James 1984; Hertel 1969, 1977).

The internal anatomy and dimensions of *T. chiodectonoides* apothecia resemble those of the widespread *T. coarctata* (Sm. & Sow.) Choisy rather closely, but seem slightly smaller in all respects. *T. coarctata* apothecia are not aggregated into subpustular spots, and the hymenial surface is normally brown and larger. The upper layer of the thallus of *T. coarctata* is undifferentiated (Hertel 1977), whereas *T. chiodectonoides* has a distinctly paraplectenchymatous upper cortex.

The chemistry of this new species is typical for a member of the Trapeliaceae, most members tested producing gyrophoric acid as the only constituent (Hertel & Leuckert 1969).

Trapelia chiodectonoides is presently known only from the type locality, the Doreen Falls area of the Cathedral Peak Reserve in the Natal Drakensberg, on Clarens (Cave) sandstone.

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F. BRUSSE*

* Botanical Research Institute, Private Bag X101, Pretoria 0001.

ZYGOPHYLLACEAE

A NEW SPECIES OF *ZYGOPHYLLUM* FROM SOUTHERN AFRICA

Zygophyllum macrocarpon *Retief*, sp. nov., *Z. foetido* Schrad. & Wendl. affinis sed fructibus adumbratione oblongis non subglobosis alabastris dense pubescentibus differt.

TYPE.— Cape, 2817 (Vioolsdrif): Richtersveld, Kodaspiek, main ridge south east of beacon and up to summit (–AA), *Oliver, Tölken & Venter 417* (PRE, holo.; K, MO).

A glabrous succulent shrub up to 1,8 m high. *Stems* woody, sparsely branched. *Leaves* fleshy, opposite, petiolate, bipinnate, broadly ovate, variable in size, 27–60 × 24–58 mm, apex rounded, base asymmetrical, margin entire; petioles 5–10 mm long. *Interpetiolar stipules* ovate to broadly ovate, 2–5 × 2–3 mm. *Flowers* 2 together in the axil of a leaf. *Sepals* 5, persistent, ovate, ± 5 × 3 mm, connate at the base, margins hairy. *Petals* 5, obovate, 15–20 × 8–12 mm, yellow with purplish brown or red markings in the throat. *Disc* fleshy, 10–angled. *Stamens* 10, inserted at the disc base; filaments terete, ± 7–7,5 mm long; anthers ± 1,5 mm long; appendages undivided, margin fimbriated, 0,25 times as long as the filament. *Ovary* sessile on the disc. 4–5-locular with several pendulous ovules in each loculus; style terete, ± 5 mm long; stigma minute. *Fruit* a 4–5-angled capsule, 5-locular with several seeds, oblong, 35–50 × 71–21 mm. *Seeds* crustaceous, ± 5 mm long, brownish black. Figure 18.

SWA/NAMIBIA.—2716 (Witputz): Udabib Mountains (–BB), *Müller 799* (PRE); Aurus Mountain (–CA), *Müller 736* (PRE); Farm Spitzkopp (–DC), *Giess 13045* (PRE).

CAPE.—2816 (Oranjemund): Sendelingsdrif (–BB), *Van der Westhuizen 133/80* (PRE); head of Helskloof, Hottentotparadys Mountain (–BD), *Thompson & Le Roux 121* (PRE, STE). 2817 (Vioolsdrif): Richtersveld, Kodaspiek, main ridge south east of beacon and up to summit (–AA), *Oliver, Tölken & Venter 417* (K, MO, PRE).

Z. macrocarpon is found on mountain slopes in the Richtersveld and the southern part of South West Africa/Namibia. The species grows in well drained stony clayey or sandy loamy soil. According to Giess (1971) in South West Africa/Namibia this species occurs in Desert and Succulent Steppe (Winter rainfall area). In the Cape *Z. macrocarpon* is found in two different veld types, namely, in Succulent Karoo and Namaqualand Broken Veld (Acocks 1975). These veld types are dominated by succulents, mainly species of Mesembryanthemaceae together with a few trees or large shrubs. According to herbarium records *Z. macrocarpon* flowers and fruits from July to September.

Z. macrocarpon is most closely related to *Z. foetidum* Schrad. & Wendl. The leaves of these two species are broadly ovate and prominently petiolate. The flowers are also similar in structure and size. *Z. foetidum* differs from *Z. macrocarpon* in having hairy flowerbuds. The fruits of *Z. macrocarpon* are oblong in outline while in *Z. foetidum* they are subglobose. These two species also differ in their distribution. *Z. foetidum* occurs from south of Springbok

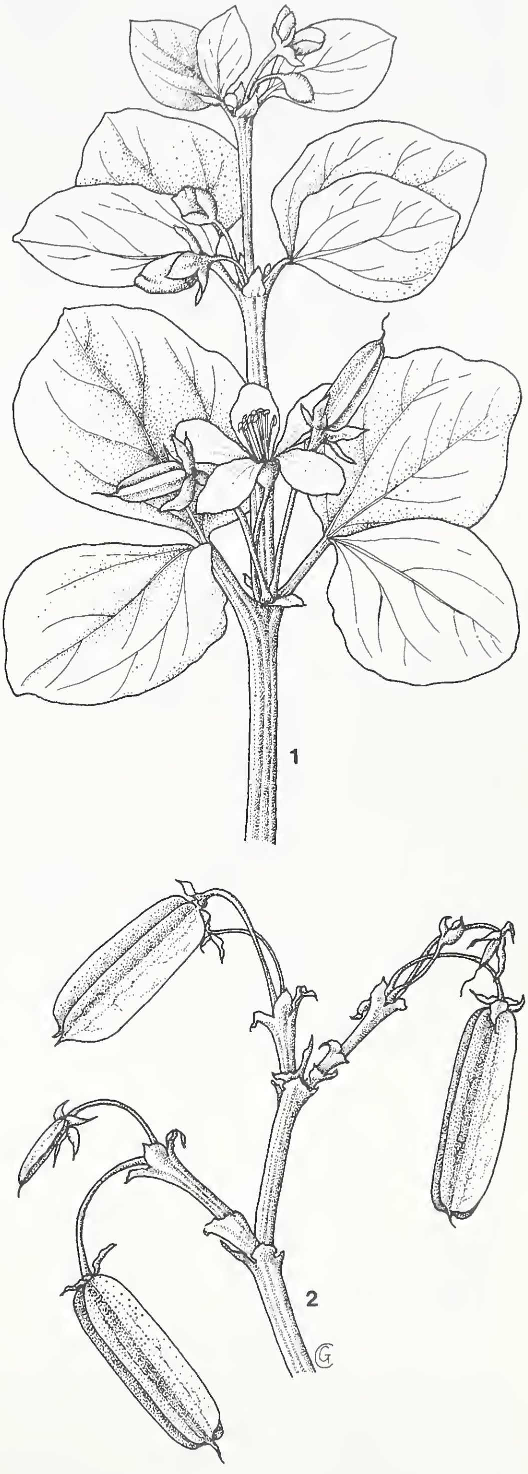

FIGURE 18.—*Zygophyllum macrocarpon*.1, flowering branch, × 1; 2, fruiting branch, × 1 *(Oliver, Tölken & Venter 417)*.

to the eastern Cape, whereas *Z. macrocarpon* is found north of Springbok.

The specific epithet 'macrocarpon' refers to the size of the fruit. These are large, oblong, and 5-angled which, together with the conspicuously large bipinnate leaves and flowers, distinguish *Z. macrocarpon* from other southern African species of *Zygophyllum*. The same fruit form is found in *Z. debile* Cham. & Schlechtd. These fruits are, however, small, 13–20 mm long, compared with *Z. macrocarpon* of which the fruits are 35–50 mm long.

Z. foetidum Schrad. & Wendl., *Z. leptopetalum* E. Mey. ex Sond. and *Z. meyeri* Sond. also have large bipinnate leaves but differ from *Z. macrocarpon* in that their fruits are subglobose in outline. The petals of *Z. macrocarpon* are 15–20 mm long, and therefore large in comparison with, for example, those of *Z. dregeanum* which are 3–4 mm long.

The flowers of *Z. fulvum* are similar in size to those of *Z. macrocarpon*, but differ in having leaflets that are elliptic in shape and not broadly ovate as in the case of *Z. macrocarpon*.

Based on the fruit dehiscence, the genus *Zygophyllum* can be divided into two subgenera, namely, *Agrophyllum* Endl. and *Zygophyllotypus* Van Huysteen. The dehiscence of the subgenus *Agrophyllum* is septicidal, whereas loculicidal dehiscence is found in the subgenus *Zygophyllotypus*. The species of this latter subgenus, indigenous in southern Africa, are grouped in different sections. *Z. macrocarpon* is placed in the section *Capensia* Engl. to which the species *Z. foetidum* also belongs.

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E. RETIEF*

* Botanical Research Institute, Private Bag X101, Pretoria 0001.

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Taxonomy of the genus *Ehrharta* (Poaceae) in southern Africa: the Villosa group

G. E. GIBBS RUSSELL*

Keywords: Fynbos, Capensis, *Ehrharta*, Poaceae, Succulent Karoo, taxonomy

ABSTRACT

The Villosa species group in the genus *Ehrharta* Thunb. is differentiated morphologically by very large, profusely hairy, bearded and aristate spikelets and by a suffrutescent habit, with culms woody at the base and with reduced leaf blades. The Villosa group is composed of two species, one with a variety: *E.* **thunbergii** Gibbs Russell, nom. nov., *E. villosa* Schult. f. var. *villosa* and *E. villosa* var. *maxima* Stapf. Members of the group occur on sandy soils in the Succulent Karoo and Fynbos Biomes, along the west coast in Strandveld and on the southern coast as far east as the Fish River. Morphologically, the group appears to be related to the Calycina and Capensis groups.

UITTREKSEL

Die Villosa-groep in die genus *Ehrharta* Thunb. word morfologies onderskei deur baie groot, dig behaarde, bebaarde en skerppuntige blompakkies asook halfstruikagtige habitus, met halms houtagtig aan die basis en met gereduseerde blaarlaminas. Die Villosa-groep sluit twee spesies in, een met 'n varieteit: *E.* **thunbergii** Gibbs Russell, nom. nov., *E. villosa* Schult. f. var. *villosa* en *E. villosa* Schult. f. var. *maxima* Stapf. Lede van die groep kom voor op sanderige gronde in die Sukkulente Karoo- en Fynbosbiome, langs die weskus in die Strandveld en aan die suidelike kus so ver oos as die Visrivier. Morfologies vertoon die groep verwantskap met die Calycina- en Capensis-groepe.

INTRODUCTION

Previous papers in this series have outlined the seven species groups of *Ehrharta* Thunb. in southern Africa (Gibbs Russell & Ellis 1987), and dealt in detail with the morphology and anatomy of the taxa in the Setacea group (Gibbs Russell 1987; Ellis 1987a). In the Villosa group, as in all the groups except the Setacea group, the first and second sterile lemmas are of similar size and ornamentation (Figure 1). The Villosa group is distinguished morphologically by large spikelets 10–18 mm long that have sterile lemmas with conspicuously bearded bases, profusely hairy sides and mucronate to aristate tips; and by a suffrutescent habit with culms woody at the base and with reduced leaf blades. Besides these characters of habit and spikelet, the two species share features in leaf anatomy (Ellis 1987b). Within the group, the species differ mainly in spikelet size, relative glume length, rhizome structure, and in habitat and distribution, as well as in anatomical characters (Ellis 1987b). All the taxa are robust and have long, stout rhizomes. They occur only in sandy soil, and are the only species of *Ehrharta* to grow on seaside dunes.

Because of the spikelet similarities, Chippindall (1955) questioned the level of treatment of the three taxa, and only described *E. villosa* in detail, including within it some of the distinctive vegetative characters of *E. thunbergii*. However, previous treatments from Schultes (1830) to Stapf (1900) distinguished two taxa (*E. villosa* Schult. f. and *E. gigantea* Thunb.) on spikelet and rhizome characters similar to those used here.

It is unfortunate that a new name was required for the species previously known as *E. gigantea* Thunb. For 194 years, since 1794, the epithet 'gigantea' has been applied to the smaller, inland specimens of the Villosa group. However, this name is based on the same type, the specimen in the Thunberg herbarium, as Linnaeus the Younger's (1781) *Aira villosa,* and therefore, as a superfluous name, was illegitimate when published. The epithet 'villosa' cannot be taken up, however, because the new combination was not made in *Ehrharta* before Schultes (1830) published his own *Ehrharta villosa,* based on a different type. No other name has been applied to the species, so a new name is necessary. It is fortunate that 'villosa' was already occupied in *Ehrharta,* or the species previously known as *E. gigantea* would have had to become *E. villosa*, and *E. villosa* would have required a new name, an even more unsatisfactory situation.

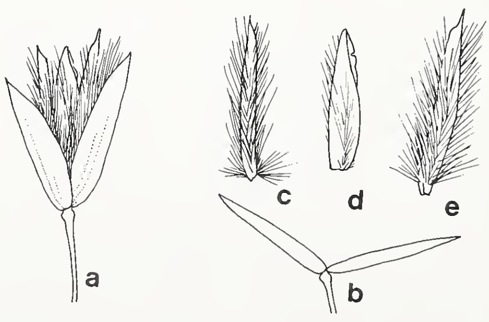

FIGURE 1. — Spikelet of *E. villosa* var. *villosa* (*Crook 2260*, PRE): a, whole spikelet; b, glumes; c, first sterile lemma; d, fertile lemma; e, second sterile lemma; all × 2.

* Botanical Research Institute, Department of Agriculture and Water Supply, Private Bag X101, Pretoria 0001.

METHODS

The descriptive data for the species and infraspecific taxa has been recorded through the DELTA computer system, originated by Watson and Dallwitz (Dallwitz 1984, Watson & Dallwitz 1980, 1985) and used previously at species level by Webster (1983). The system has the advantage of recording comparable character states for each taxon in a form that can be used to generate descriptions, keys and an online identification facility, and that can be used directly for classificatory studies. Because of this change in methodology, the descriptions given from now on include more characters than were previously recorded, and are strictly comparable.

KEY TO SPECIES IN THE VILLOSA GROUP

Glumes $\frac{1}{2}$–$\frac{3}{4}$ as long as spikelet, 5-nerved, upper glume to 8 mm long; spikelets 8–10 mm long; rhizomes densely covered with hairy cataphylls, internodes often sub-bulbous .... 1. *E. thunbergii*

Glumes $\frac{3}{4}$ as long to about equalling spikelet, 5–9-nerved, upper glume 8–13 mm long; spikelets (10–) 11–18 mm long; rhizomes naked, neither sub-bulbous nor bulbous .... 2. *E. villosa*

1. **Ehrharta thunbergii** *Gibbs Russell,* nom. nov. Type: *Thunberg,* (sheet 8851, UPS, holo.-PRE, microfiche!).

Aira villosa L. f., Supplementum plantarum: 109 (1781). *Melica gigantea* Thunb.: 21 (1794). *Ehrharta gigantea* (Thunb.) Swartz: 58 (1802); Thunb.: 339 (1818); Schrader: 2079 (1821); Thunb.: 336 (1823); Schult.: 1375 (1830); Trinius: 16 (1839); Nees: 216 (1841); Steudel: 5 (1855); Stapf: 680 (1900); Chippindall: 45 (1955). Type: *Thunberg,* (sheet 8851, UPS,–PRE microfiche!).

Ehrharta gigantea (Thunb.) Swartz var. *neesii* Stapf: 680 (1900). Type: *Drège,* near Riebeecks Castle, among shrubs (K, holo.!).

Ehrharta gigantea (Thunb.) Swartz var. *stenophylla* Stapf: 881 (1900). Type: *Schlechter 9058* (K, holo.!).

Perennial, tufted, erect, long-rhizomatous, robust, suffrutescent. *Rhizomes* often with internodes sub-bulbous, clad with imbricate, thickened, hairy cataphylls. *Culms* several, to 1,5 m tall, 3 mm across, woody, solid, sometimes geniculate at lower nodes, crowded, branched at base, sometimes branching in fascicles above, nodes usually black, rarely with ascending hairs, the lowest internode sometimes sub-bulbous, the 'bulb' pale orange, polished, shining. Young shoots intravaginal. *Leaves* mostly basal, persistent, culm leaves usually with blades reduced, often auriculate from mouth of sheath, the auricles rarely accrescent, to 10 mm long, with bristly edges; basal sheaths loose, papery, often splitting into fibres, grey or whitish; culm sheaths not overlapping; ligule a fringed membrane 0,5 mm long; blades persistent, linear, to 5 mm across, flat or rolled, gradually tapering at the tip, erect or spreading, herbaceous, usually glabrous, but sometimes hairy. *Inflorescence* a fascicled panicle, narrow, often sinuous, to 160 mm long, somewhat overtopping leaves, exserted from uppermost leaf sheath, of numerous spreading spikelets. *Spikelets* pedicellate on filiform curled pedicels, laterally compressed, 8–10 mm long, 2–3 mm across above glumes. Glumes keeled, subequal, $\frac{1}{2}$–$\frac{3}{4}$ as long as the spikelet, translucent, sometimes purple-tinged; lower glume to 6 mm long, 5-nerved, acute; upper glume to 8 mm long, 5-nerved, acute. *Florets* with lemmas decidedly firmer than the glumes, keeled. Sterile lemmas slightly rounded on sides, similar in shape and texture. First sterile lemma $\frac{2}{3}$–$\frac{3}{4}$ length of second sterile lemma, with keel and margins parallel; base substipitate, conspicuously bearded; sides with profuse long spreading white hairs, otherwise smooth and unornamented, dull; tip abruptly aristate from keel, aristae to $\frac{1}{3}$ length of lemma, usually dark purple. Second sterile lemma similar to first sterile lemma, but larger and distinctly stipitate. *Fertile floret* shorter than second sterile lemma, lemma differing from sterile lemmas, strongly laterally compressed, sides apparently nerveless, sparsely hairy, tip truncate; palea $\frac{3}{4}$ or more as long as lemma, keeled, 1-nerved. Lodicules 2, membranous, 2-lobed. Stamens 6, anthers 5 mm long, white. Stigmas white. *Caryopsis* not seen.

This species is distinguished from other *Ehrharta* species by the large hairy spikelets with short, translucent glumes and the sub-bulbous rhizomes with hairy cataphylls. It is the most widespread and abundant of the members of the Villosa group, and its distribution is shown in Figure 2. Unlike most Ehrhartas, which tend to have an 'eastern' or 'western' distribution, its range extends both northwards through Fynbos, Strandveld, and Succulent Karoo to the southern border of South West Africa/Namibia and eastward along the coastal ranges as far as Mossel Bay. However, it appears to be less common in the eastern part of the range.

Stapf's two varieties are not recognized because they intergrade with the more common and widespread form, and because they are not distinguished by a separate range or habitat. However, each of these forms shows an interesting link to the Capensis group. 'Bulbous' basal internodes (var. *stenophylla*) are characteristic of most species in the Capensis group, and the specimens with many-noded geniculate culms with small flat leaf blades (var. *neesii*) are similar in habit to the only non-bulbous member of the Capensis group, *E. barbinodis*. There is in addition a form with broad and often hairy leaves (for example, *Gibbs Russell 5619*) that occurs from Calvinia to Lambert's Bay and Piketberg. A few specimens intermediate to *E. villosa* var. *villosa* are discussed under that variety.

E. thunbergii grows in sandy or sandy gravel soils, mostly on hill slopes, but also in coastal sand and

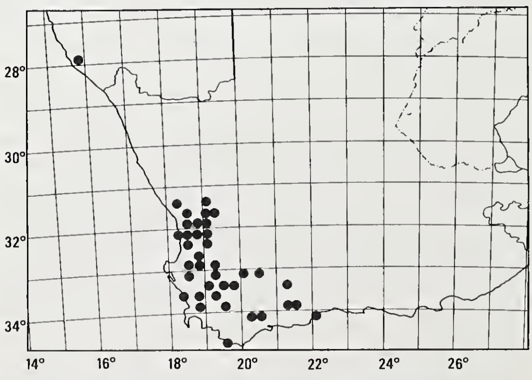

FIGURE. 2. — Distribution of *E. thunbergii*.

occasionally beside watercourses. Flowering occurs from September to December.

Vouchers: *Acocks 23393*; *Andreae 1314*; *Boucher 4724*; *Liebenberg 6551*; *Schlechter 10208*.

2. **Ehrharta villosa** *Schult. f.* in Systema vegetabilium 7,2: 1374 (1830). Trinius: 16 (1839); Nees: 213 (1841); Steudel: 5 (1855); Stapf: 681 (1900); Chippindall: 45 (1955); Smook & Gibbs Russell: 55 (1985). Type: *Ecklon,* Promont. b. spei, in arenosis maritimis (P, holo.).

Perennial, tufted, erect, long-rhizomatous, robust, suffrutescent. *Rhizomes* woody, naked. *Culms* several, to 1,5 m tall, woody, solid, branched at base, branching in fascicles above, nodes glabrous, lowest internode never bulbous. Young shoots intravaginal. *Leaves* not basally aggregated, culm leaves with blades reduced, often auriculate from mouth of sheath, the auricles not accrescent; basal sheaths loose, papery, grey or whitish; culm sheaths not overlapping; ligule a fringed membrane 0,5 mm long; blades deciduous or persistent on basal sheaths and culm sheaths, linear, to 8 mm across, but rolled and appearing setaceous, gradually tapering at the tip, herbaceous, glabrous. *Inflorescence* a fascicled panicle, narrow, sometimes sinuous, 40–260 mm long, somewhat overtopping leaves, exserted from or sometimes closely subtended by uppermost leaf sheath, of numerous spreading spikelets. *Spikelets* pedicellate on filiform curled pedicels, laterally compressed, (10–) 11–18 mm long, 3–4 mm across above glumes. Glumes keeled, more or less equal, $\frac{3}{4}$ as long to slightly longer than rest of spikelet, opaque white, sometimes purple-tinged; lower glume 8–13 mm long, 5–9-nerved, acute; upper glume 9–18 mm long, 5–9-nerved, acute. *Florets* with lemmas decidedly firmer than the glumes, keeled. Sterile lemmas slightly rounded on sides, similar in shape and texture. Sterile lemmas similar to *E. thunbergii*, but first sterile lemma with tip abruptly mucronate or aristate from keel, purple or pale. Second sterile lemma similar to first sterile lemma, but larger and distinctly stipitate. *Fertile floret* similar to *E. thunbergii* but anthers 6–8,5 mm long, brownish yellow. *Caryopsis* 5,5 mm long, ovate, flattened.

This species grows on sea dunes from Lambert's Bay to Port Alfred, and is our only indigenous grass that behaves as a 'marram'. It is distinguished from *E. thunbergii* by its naked rhizomes and longer spikelets with comparatively longer glumes.

KEY TO VARIETIES

Inflorescence exserted from uppermost leaf sheath, the sheath usually not inflated; upper glume 9–13 mm long; culms to 3 mm across ....2a. *E. villosa* var. *villosa*

Inflorescence closely subtended or enveloped by inflated uppermost leaf sheath; upper glume (10–) 13–18 mm long; culms to 5 mm across ....2b. *E. villosa* var. *maxima*

2a. var. **villosa.** Stapf: 681 (1900); Chippindall: 45 (1955); Smook & Gibbs Russell: 55 (1985).

Culms robust, to 3 mm across. *Inflorescence* interrupted, to 150 mm long, usually exserted from uppermost leaf sheath, the sheaths usually not inflated. *Spikelets* 11–14 mm long, to 3 mm across laterally above glumes. Glumes $\frac{3}{4}$ as long to slightly shorter than rest of spikelet; lower glume 8–12 mm long; upper glume 9–13 mm long. *Florets* with sterile lemmas mucronate or aristate. Anthers 7,5–8 mm long.

Variety *villosa* is distinguished from var. *maxima* by its exserted inflorescences, smaller stature and somewhat smaller spikelets. The two varieties are sympatric throughout most of their distribution (Figures 3 & 4), although this one extends farther north on the west coast and is more common in the south-western Cape.

A few intermediate specimens occur, always near the sea but not on seaside dunes, that have small glumes and spikelets like *E. thunbergii*, but naked rhizomes like *E. villosa*: *Ellis 4640* from Lamberts Bay; *Gibbs Russell 5670* from the Cape Peninsula; and *Liebenberg 4015* from Mossel Bay. Most of the specimens from Mossel Bay, to the east of the range of both this variety and of *E. thunbergii,* appear to be of this intermediate type, although these intermediates are few and sporadic elsewhere. Inland, rare intermediate specimens show a different pattern of variation. *Ellis 4693*, from the roadside at Cloete's Pass, has the hairy rhizome cataphylls of *E. thunbergii* and the larger spikelets with long glumes of *E. villosa. Emdon 200,* from disturbed Fynbos, has large glumes that are translucent.

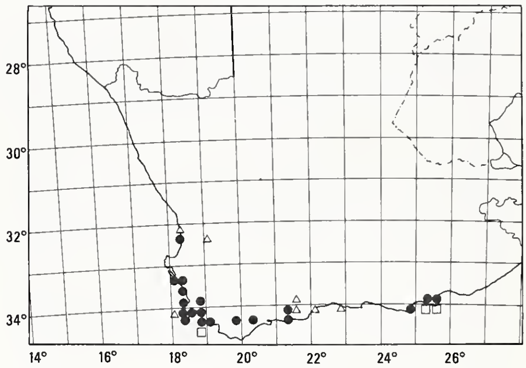

FIGURE. 3. — Distribution of *E. villosa* var. *villosa.* Intermediates to *E. thunbergii* are shown by triangles, △. Intermediates to *E. villosa* var. *maxima* are shown by squares, □. Where symbols would be superimposed, those for intermediates are shown apparently in the sea directly below or to the left of the correct quarter degree.

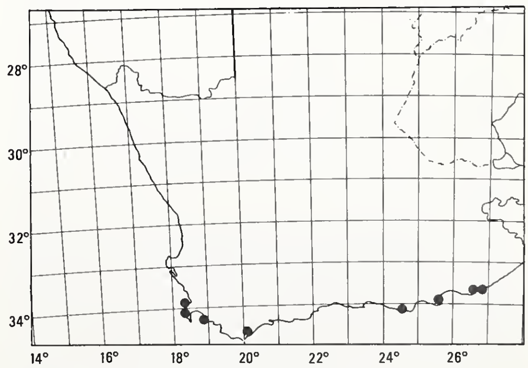

FIGURE. 4. — Distribution of *E. villosa* var. *maxima.*

The intermediates, all mapped in Figure 3 with *E. villosa* var. *villosa,* occur either at the extremeties of the distribution of this variety, or in disturbed habitats, and all occur within the range of *E. thunbergii.* Furthermore, no intermediates are known from the part of the range of *E. thunbergii* that lies outside that of *E. villosa*. Therefore, the hypothesis that most likely accounts for the intermediates is that they are the result of hybridization between the two taxa.

Variety *villosa* grows most commonly on seaside dunes, but has been collected as far as 1 km inland on the limestone ridges at De Hoop, although still in sandy soil. It flowers from October to December.

Vouchers: *Bohnen 4541*; *Cleghorn 3122*; *Crook 2260*; *Marloth 3046*; *Smith 4649*.

2b. var. **maxima** *Stapf* in Flora capensis 7: 681 (1900). Chippindall: 45 (1955); Smook & Gibbs Russell: 55 (1985).

Culms very robust, to 5 mm across. *Inflorescence* dense, to 260 mm long, closely subtended or enveloped by uppermost inflated leaf sheath. *Spikelets* (10–) 12–18 mm long, to 4 mm across laterally above glumes. Glumes slightly shorter to slightly longer than rest of spikelet; lower glume 9–13 mm long; upper glume (10–) 13–18 mm long. *Florets* with first sterile lemma tip mucronate. Anthers 6–8,5 mm long.

The distribution of this variety is shown in Figure 4. It extends as far east as Port Alfred, where it is the only *Ehrharta* on the dunes, but extends no farther than the Cape Peninsula. It is less common than var. *villosa* in the western part of its range, where it is known from a few specific sites, such as Robben Island. It is recognized at varietal rather than subspecific rank because of the close similarity between the two taxa in morphology, anatomy, distribution and habitat.

Variety *maxima* occurs only on seaside dunes, and flowers from September sporadically to March.

Vouchers: *Boucher 1689*; *Britten 778*; *Theron 1108*; *Tyson Herb. Marl. No. 8598*; *UPE Staff 158*.

CONCLUSION

This closely related group of species shows a cline in size, from the smaller, aristate forms of *E. thunbergii* on Namaqualand hillsides, to the robust, short-mucronate, dune-binding *E. villosa* var. *maxima* at Port Alfred. *E. villosa* var. *villosa*, which is concentrated geographically in the middle part of the distribution of the group, also has morphological and anatomical (Ellis 1987b) intermediates to both the other taxa. The rhizome differences between the species may be related to habitat differences. In the shifting dune sands there are no cataphylls and no bulb-like structures.

Relationships of the Villosa group to other species groups appear somewhat different when examined morphologically and anatomically. Morphologically, the Villosa group is linked to the Calycina group by the hairy spikelets with long glumes, and to the Capensis group by the large spikelets with short-awned or mucronate and stipitate sterile lemmas, and by the 'bulbous' internodes. Ellis (1987b) reports anatomical links to the Calycina group, which is similar anatomically to the Capensis group. However, the suggested anatomical link to the Ramosa group is shown morphologically in only one species in the Ramosa group, which has long glumes and suffrutescent culms.

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Leaf anatomy of the genus *Ehrharta* (Poaceae) in southern Africa: the Villosa group

R. P. ELLIS*

Keywords: *Ehrharta, E. thunbergii, E. villosa,* leaf anatomy, Poaceae, stomatal flanges, systematics

ABSTRACT

The leaf blade anatomy of *Ehrharta villosa* Schult. f. var. *villosa,* var. *maxima* Stapf and *E. thunbergii* Gibbs Russell is described and illustrated. These three taxa, constituting the Villosa species group, share a diagnostic leaf anatomy distinguished by the absence of a distinct midrib, adaxial semi-radiate mesophyll with the abaxial chlorenchyma palisade-like in arrangement, rectangular long cells and the stomatal apertures which are overlapped by four cuticular flanges projecting from the two adjacent interstomatal cells. These combined attributes characterize this species group, and the stomatal flanges are unique to this group in the genus *Ehrharta* Thunb. Microhairs are absent in *E. villosa* but are present in *E. thunbergii* which also possesses abaxial prickles and plentiful, rounded silica bodies not associated with cork cells as in *E. villosa.* These two taxa can, therefore, be separated anatomically. Nevertheless, they share many features and are undoubtedly closely related and their classification in the same species group is substantiated by the anatomical evidence presented in this paper.

UITTREKSEL

Die blaarskyfanatomie van *Ehrharta villosa* Schult. f. var. *villosa* en var. *maxima* Stapf en *E. thunbergii* Gibbs Russell word beskryf en geïllustreer. Hierdie drie taksons, wat die Villosa-spesiegroep verteenwoordig, vertoon 'n diagnostiese blaaranatomie, gekenmerk deur die afwesigheid van 'n duidelike hoofaar, semi-radiale adaksiale mesofil met die abaksiale chlorenchiem palisade-agtig gerangskik, reghoekige langselle en die huidmondjie-openinge wat oorvleuel word deur vier kutikulêre krae wat vanaf die twee aangrensende selle strek. Dié kombinasie van kenmerke onderskei hierdie spesiegroep, en die huidmondjie-krae is uniek by hierdie groep in die genus *Ehrharta* Thunb. Mikrohare is afwesig by *E. villosa* maar aanwesig by *E. thunbergii* wat ook abaksiale stekelhare en volop ronde silikaliggaampies, wat nie met kurkselle geassosieer is soos by *E. villosa* nie, besit. Hierdie twee taksons kan dus anatomies onderskei word maar het nietemin baie kenmerke gemeen en is ongetwyfeld nouverwant aan mekaar en hul klassifikasie in dieselfde spesiegroep word ondersteun deur anatomiese gegewens wat hier aangebied word.

INTRODUCTION

The species of the Villosa group of the genus *Ehrharta* Thunb. are distinguished morphologically by their large spikelets with profusely hairy, conspicuously bearded and mucronate sterile lemmas (Gibbs Russell & Ellis 1987). The leaf blades are reduced and rolled and the culms are suffrutescent, sometimes with swollen or tuberous bases. Creeping, underground rhizomes occur in all taxa.

Taxa included in this group are *Ehrharta villosa* Schult. f. var. *villosa* and var. *maxima* Stapf, and *E. thunbergii* Gibbs Russell (= *E. gigantea* Thunb.). Chippindall (1955) considered *E. villosa* var. *villosa* and *E. thunbergii* to be conspecific, whereas Smook & Gibbs Russell (1985) synonomize *E. villosa* var. *maxima* and *E. thunbergii.* In the present treatment *E. thunbergii* is considered as a separate species following Gibbs Russell (1987) and consequently, three taxa are assigned to the Villosa species group.

The leaf blade anatomy of taxa belonging to this species group has received very little attention from previous workers. Metcalfe (1960) gives a full description of *E. villosa* var. *maxima* and Engelbrecht (1956) also describes the leaf anatomy of *E. villosa* based on a representative sample of 18 specimens, 8 identified as *E. villosa* and 10 as *E. thunbergii* (= *E. gigantea*) but considered as a single species.

This paper describes and illustrates the leaf blade anatomy of the taxa of the Villosa group and discusses the affinities of these taxa and of the species group by reference to this anatomical evidence. By implication the anatomical data is compared and contrasted with the morphological data as it is reflected in the classification of the group (Gibbs Russell 1987). The herbarium voucher specimens used in this anatomical study were included in the sample on which the above taxonomic conclusions were based. The methodology is described in Gibbs Russell & Ellis (1987) and the format of the paper follows that of the first paper in the series (Ellis 1987a).

LEAF ANATOMY OF THE SPECIES OF THE VILLOSA GROUP

E. villosa *Schult. f.*

Transverse section

The leaf blade is loosely inrolled (Figures 1.1, 2.1, 2.3, 3.1, 3.3) without a distinguishable keel, the median vascular bundle being structurally identical to the lateral first order bundles (Figures 1.1, 2.3, 3.3). Successive first order bundles are separated by 2–3 third order bundles except laterally where only a single smaller bundle is located between successive first order bundles.

* Botanical Research Institute, Department of Agriculture and Water Supply, Private Bag X101, Pretoria 0001.

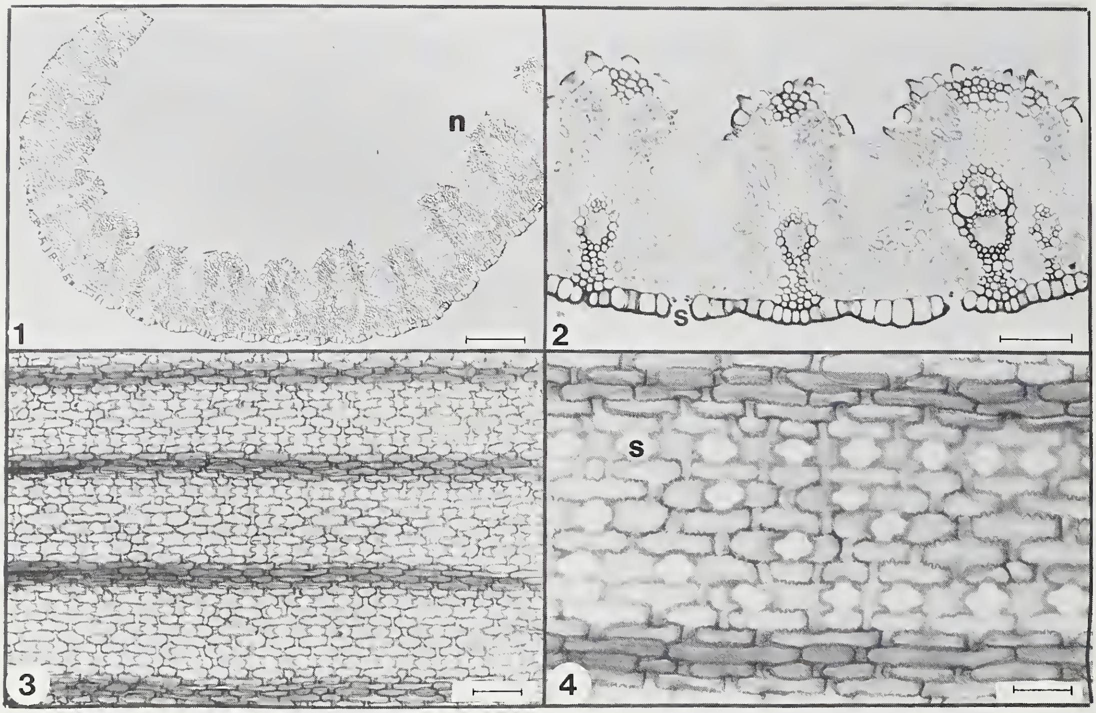

FIGURE 1. — Leaf anatomy of *Ehrharta villosa* var. *maxima*, *Ellis 601*: 1–2, leaf in transverse section: 1, vascular bundle arrangement and absence of keel (n), scale bar = 20 μm; 2, anatomical detail with sunken abaxial stomata (s) and mesophyll with adaxially located chlorenchyma cells radiately arranged and abaxial cells palisade-like, scale bar = 10 μm. 3–4, abaxial epidermis: 3, epidermal zonation with costal (darkly staining) and intercostal zones, scale bar = 10 μm; 4, short intercostal long cells and flanged interstomatal cells with flanges projecting over the sunken stomata (s), scale bar = 5 μm.

Rounded adaxial ribs are associated with all the vascular bundles (Figures 1.2, 2.2, 2.4, 3.2, 3.4), those of the first order bundles being slightly larger. Shallow, but rather narrow, furrows are present between all the ribs.

The mesophyll tissue is unusual in that it is semi-radiate in arrangement, particularly the adaxially situated cells located in the ribs (Figures 1.2, 2.2, 2.4), but the arrangement of the abaxial layers of chlorenchyma cells is palisade-like (Figure 2.2, 2.4) and may be conspicuous due to denser chloroplast concentrations (Figure 3.4). The chlorenchyma cells are relatively large, somewhat variable in shape but tightly packed so that no large intercellular air spaces are visible in transection (Figures 2.2, 2.4). The chloroplasts are evenly but densely distributed throughout all the chlorenchyma cells.

Abaxial epidermis

Costal and intercostal zones are clearly differentiated (Figure 1.3, 2.5) due to differential staining, although the epidermal cells of these two zones do not necessarily differ greatly in structure (Figure 2.6). The costal zones lack stomata and consist of narrower cells (Figure 1.4). The intercostal long cells are rather short, and rectangular with slightly undulating walls. The cells of the central files of each zone may tend to be longer and wider than the lateral cells (Figure 2.5). These larger cells are sometimes also evident in the leaf sections (Figure 1.2, 2.4).

Stomata are common in 3–5 files in each intercostal zone (Figure 1.3, 2.5).They are clearly sunken well below the level of the rest of the epidermis with the guard and subsidiary cells being overlapped by four distinct cuticular flanges extending over the stomatal aperture from the adjacent interstomatal long cells (Figures 1.2, 2.2, 2.4). In surface view a distinct cross-shaped aperture is formed by these flanges, below which the stomatal apparatus is located (Figure 1.4, 2.6). SEM studies reveal that the flanges are papilla-like (Figures 4.1–4.4).

Costal silica bodies are not well differentiated and are usually small, rounded and intimately associated with an enfolding cork cell (Figure 1.4, 2.6). In less typical specimens, however, the silica bodies may be much more evident and numerous (Figures 6.1, 6.3). Prickles are absent but prickles are present on the adaxial costal zones which are equivalent to the ribs as seen in transverse section (Figures 1.2, 2.4, 3.2). No microhairs were seen either with the light or the scanning electron microscope (Figures 1.4, 2.6, 4.1–4.4).

Specimens examined

E. villosa var. *villosa*

CAPE.—3218 (Clanwilliam): Lamberts Bay (–AB), *Ellis 4640* (atypical tending toward *E. thunbergii*). 3318 (Cape Town): Darling Dist., Yzerfontein (–AC), *Ellis 1686*. 3420 (Bredasdorp): Bredasdorp Dist., De Hoop Nature Reserve (–AD), *Ellis 1284, 4665*. 3421 (Riversdale): Mossel Bay Dist., Albertinia (–BA), *Ellis 1651* (atypical tending toward *E. thunbergii*).

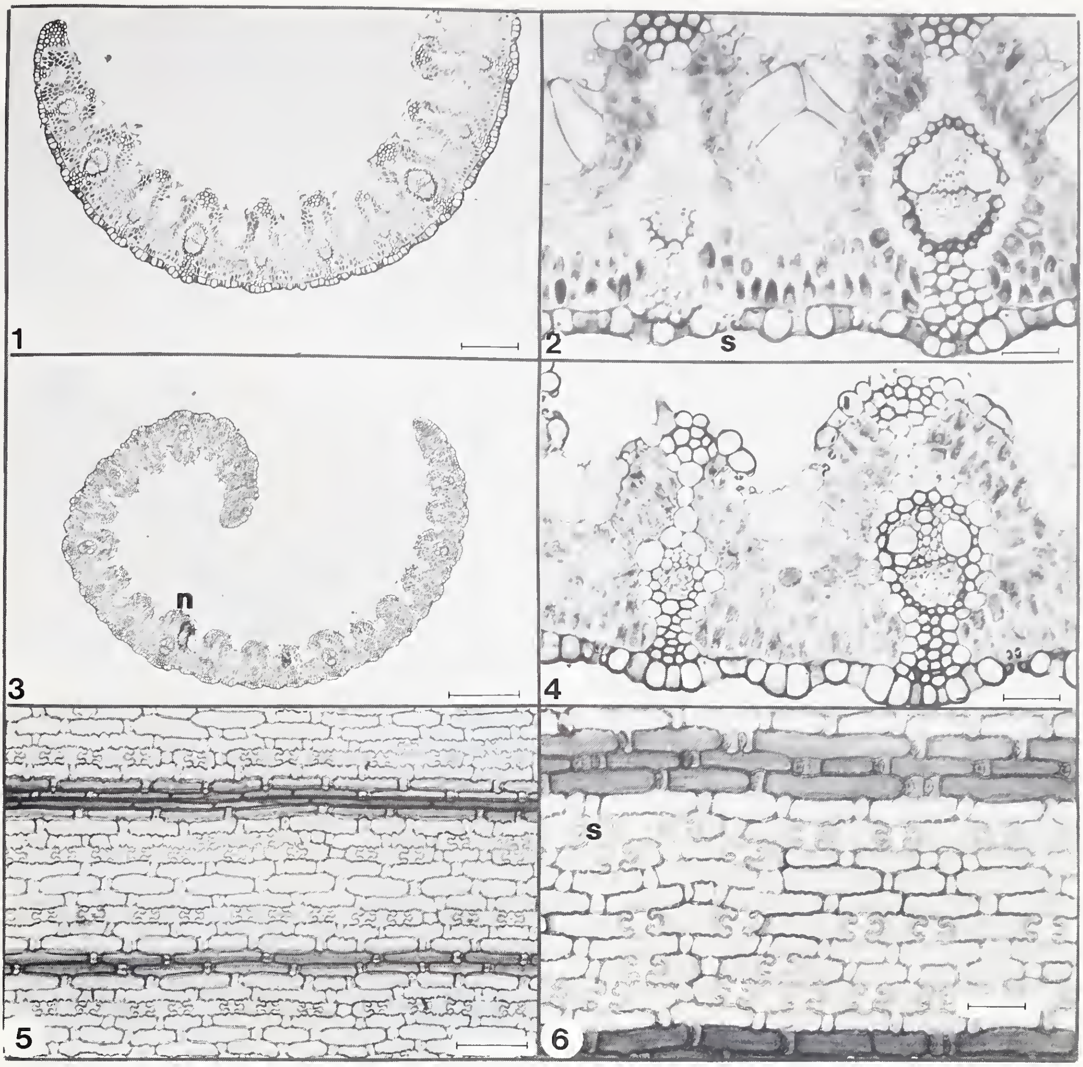

FIGURE 2. — Leaf anatomy of *Ehrharta villosa* var. *villosa* specimens resembling var. *maxima* in structure. 1–2, *Ellis 1686,* leaf blade transection: 1, loosely inrolled blade without a keel, scale bar = 20 μm; 2, detail of the chlorenchyma showing dense abaxial palisade-like cells; note sunken stomata (s) with overlapping flanges, scale bar = 5 μm. 3–4, *Ellis 1284,* transection: 3, inrolled leaf, median vascular bundle (n) only, scale bar = 20 μm; 4, anatomical detail showing sunken guard cells and radiate arrangement of the chlorenchyma, scale bar = 5 μm. 5, *Ellis 1284,* abaxial epidermis with costal zones and intercostal zones with stomatal files, scale bar = 10 μm. 6, *Ellis 1686,* abaxial epidermis with detail of stomatal flanges (s) and costal zones, scale bar = 5 μm.

E. villosa var. *maxima*

CAPE.—3325 (Port Elizabeth): Port Elizabeth, Swartkops Beach (–DC), *Ellis 601.*

Comments

E. villosa possesses the characteristic leaf anatomy of the Villosa group being distinguished by the absence of a keel or midrib, the palisade-like abaxial mesophyll, the flanged stomata, and the rectangular long cells. The anatomy of var. *villosa* and var. *maxima* is very similar and these two taxa appear to show close affinities, being indistinguishable on leaf blade anatomy, a fact which appears to corroborate their separation at only the varietal level.

Although the var. *maxima* anatomical sample used in this study is inadequate, the specimen examined *(Ellis 601)* conforms in all respects to the description given by Metcalfe (1960) for material from Western Australia even though his microtechnique procedures did not allow a detailed examination of the mesophyll. These two specimens reveal that the leaf anatomy of var. *maxima* conforms very closely with that of var. *villosa,* with some specimens of the latter being virtually indistinguishable from var. *maxima* in leaf anatomy (Figures 2.1–2.6).

E. villosa var. *villosa* is a rather variable taxon anatomically. Some specimens of var. *villosa* correspond very closely in leaf size and thickness to the relatively large leaves of var. *maxima,* as a compari-

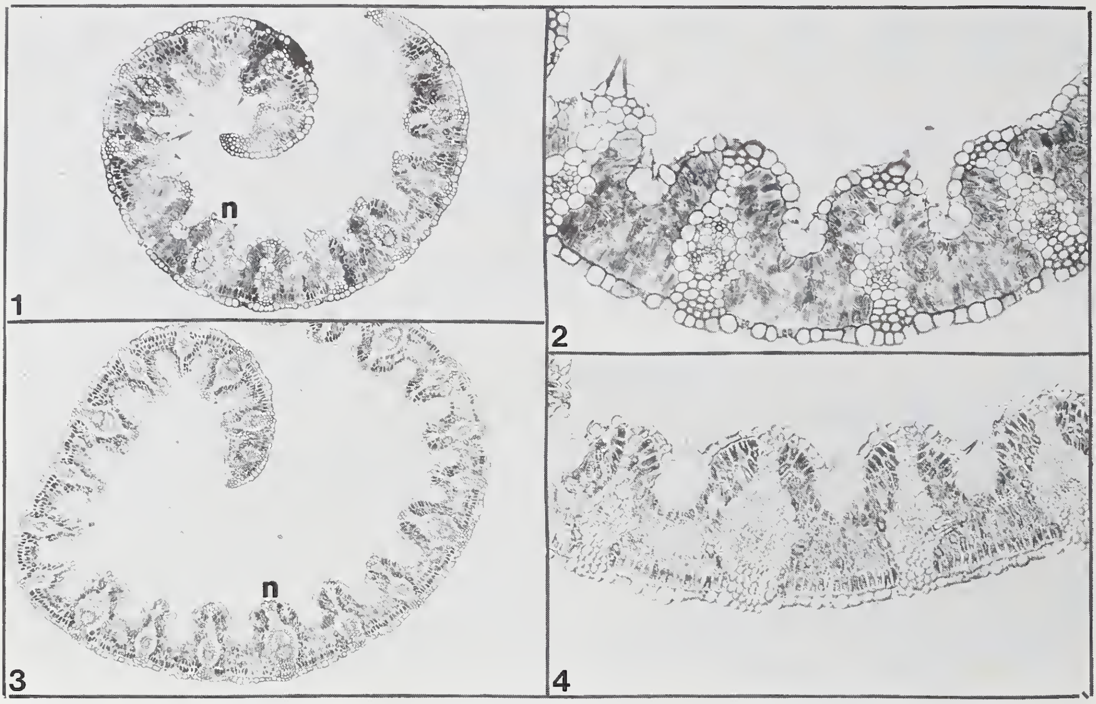

FIGURE 3. — Transectional leaf anatomy of *Ehrharta villosa* var. *villosa*. 1–2, *Ellis 4665*: 1, inrolled outline with median bundle (n) only, scale bar = 20 μm; 2, anatomical detail showing rather angular chlorenchyma cells with radiate adaxial layers and palisade-like abaxial layers, scale bar = 10 μm. 3–4, *Ellis 4640*: 3, inrolled outline without additional parenchyma in association with the median bundle (n), scale bar = 20 μm; 4, interference contrast illumination of detail of chlorenchyma cell arrangement, scale bar = 10 μm.

son of Figures 1.1, 1.2 and 2.1–4 shows. Others, however, resemble *E. thunbergii* with thinner leaves (Figures 3.3, 3.4). A similar trend is also evident in the epidermal structure, with Figures 2.5, 2.6 resembling the var. *maxima* condition, whereas Figures 6.1, 6.3 approximate closely some of the *E. thunbergii* specimens. *E. villosa* var. *villosa,* therefore, is intermediate in leaf anatomy between var. *maxima* and *E. thunbergii* and the interface between these two taxa is not very distinct.

The intermediate nature of var. *villosa* is also evident in its spikelet size and habitat requirements and several specimens have proved difficult to assign to either var. *villosa* or *E. thunbergii* on morphological criteria. This is particularly the case if the rhizome characters are not evident. But *E. villosa* is a species of deep, loose sand of the lowland fynbos and only occurs at higher altitudes where drift sand occurs as a result of wind or water deposition.

The clinal variation in anatomical structure in var. *villosa* appears to be a reflection of these habitat gradients. Those specimens most resembling var. *maxima* are all from coastal dune habitats (Figures 2.1–2.6) to which var. *maxima* appears to be confined. With increasing altitude and distance from the sea the var. *villosa* specimens (Figures 3.1–3.4, 6.1, 6.3) tend to merge with *E. thunbergii,* which is a species of higher altitudes, heavier soils and the mountain fynbos.

E. thunbergii *Gibbs Russell*

Transverse section

Blade loosely to rather tightly inrolled (Figures 5.3, 5.5). A slight keel may sometimes be developed, as evidenced by the presence of additional colourless parenchyma associated with the median vascular bundle (Figures 5.3, 5.5). This development is not equally evident in all specimens and several have the median bundle structurally identical to the lateral first order bundles, without additional parenchyma (Figure 5.1). One or two third order bundles occur between consecutive first order bundles.

Adaxial ribs are slight but rounded (Figure 5.2) or may be more conspicuous but then abaxial intercostal ribs alternate with the adaxial costal ribs (Figures 5.4, 5.5). Adaxial furrows are shallow and wider than in *E. villosa.*

The mesophyll is rather variable but all specimens conform to the general pattern so characteristic of this group. Examples with semi-radiate chlorenchyma with an abaxial palisade-like layer are illustrated in Figures 5.2, 7.1 and 7.3 and correspond closely to the *E. villosa* specimens illustrated in Figures 3.2 and 3.4. Other *E. thunbergii* specimens, with thinner leaves and fewer chlorenchyma cell layers differ slightly from this pattern (Figure 5.4). The chlorenchyma cells themselves remain rather large, somewhat angular and tightly packed with very small intercellular air spaces (Figures 5.2, 5.4).

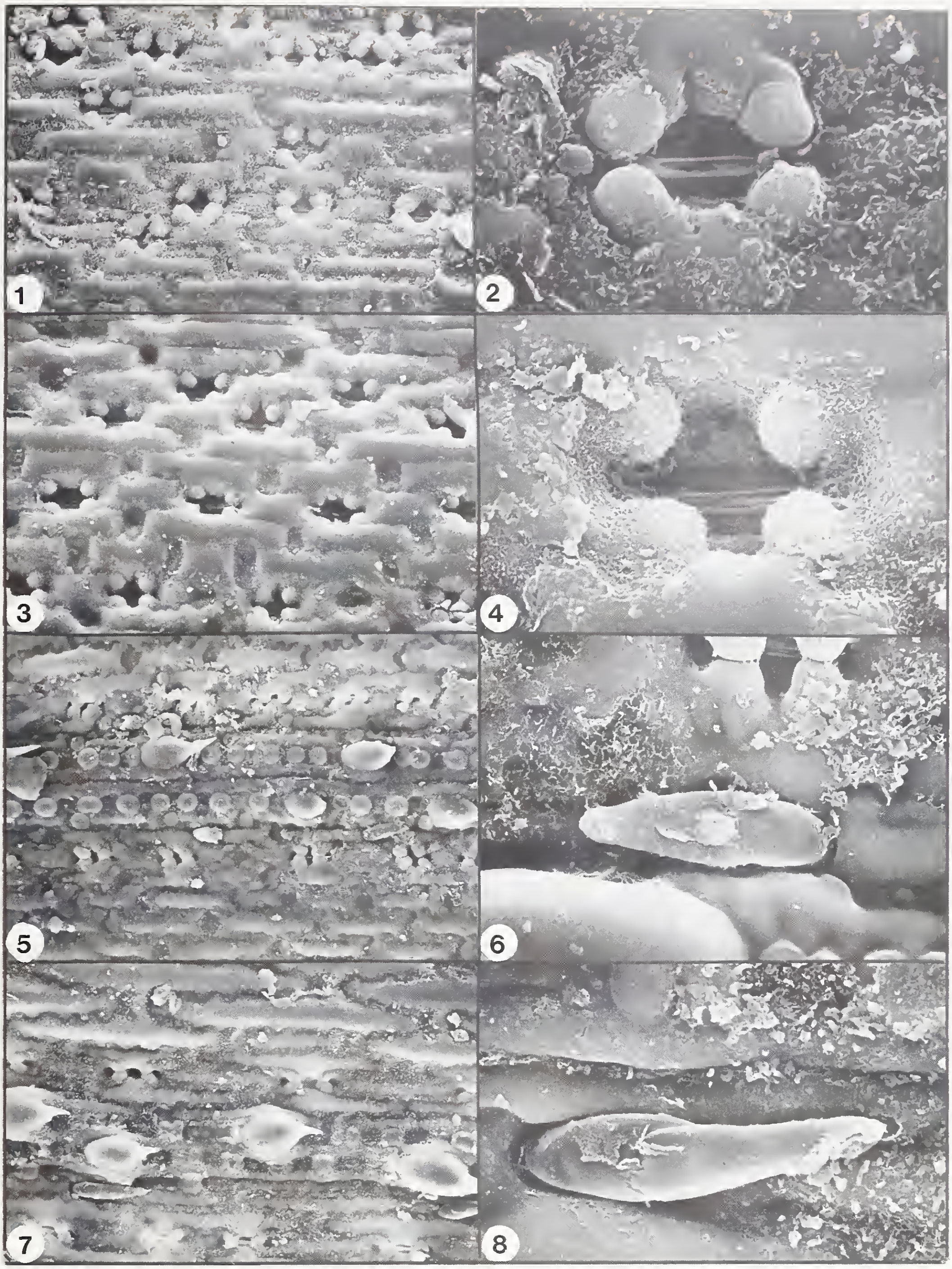

FIGURE 4. — Abaxial epidermal ultrastructure of representatives of the Villosa group. 1–4 *Ehrharta villosa* var. *villosa*. 1–2, *Ellis 4640*: 1, thickened epidermal cells, no microhairs and flanged stomata, × 200; 2, detail of the four papilla-like flanges overarching the stomatal apparatus with the guard cells visible below this aperture, × 1000. 3–4, *Ellis 4665*: 3, thick cuticle, sunken stomata and microhairs absent, × 200; 4, guard cells beneath the overarching papillate flanges, × 1000. 5–8, *Ehrharta thunbergii*. 5–6, *Ellis 4648*: 5, distinct costal zone with raised, round silica bodies and prickles; intercostal zone with microhairs and files of flanged stomata, × 200; 6, detail of microhair with tapering distal cell and flanges obscuring adjacent stoma, × 1000. 7–8, *Ellis 4626* illustrating anatomical variation in *E. thunbergii*: 7, costal prickles, intercostal microhairs and flanged stomata, but note the diamond-shaped intercostal long cells, × 200; 8, microhair with tapering distal cell, × 1000.

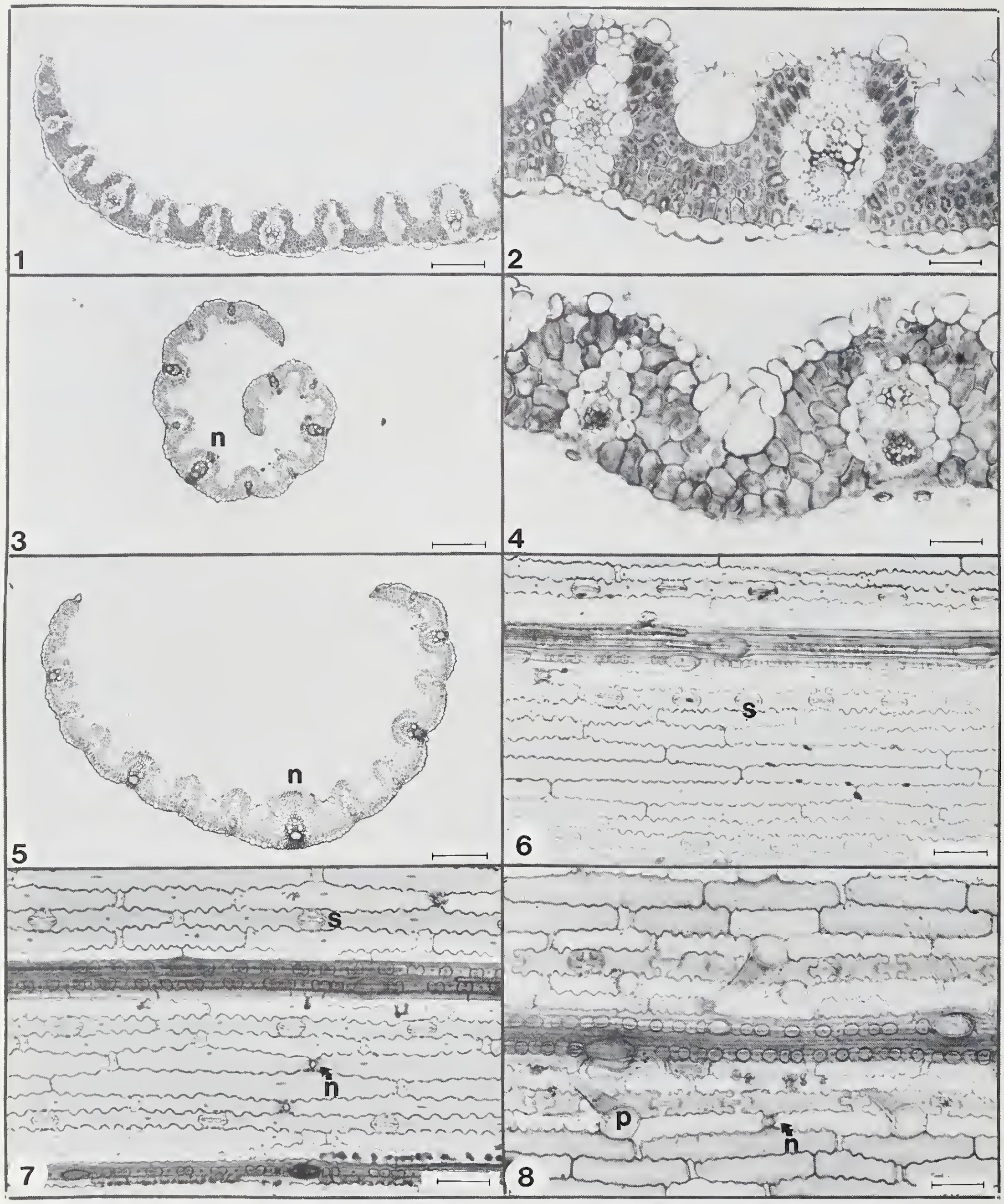

FIGURE 5. — Leaf anatomy of *Ehrharta thunbergii*. 1–5, leaf transections; 6–8, abaxial epidermides. 1–2, *Ellis 1152*: 1, median bundle not structurally distinct, scale bar = 20 µm; 2, chlorenchyma cell detail and arrangement typical of that of the Villosa group, scale bar = 5 µm. 3–4, *Ellis 708*: 3, inrolled blade with slight keel (n), scale bar = 20 µm; 4, detail showing less pronounced radiate and palisade chlorenchyma arrangement and abaxial ribs, scale bar = 5 µm. 5–6, *Ellis 1145*: 5, leaf outline showing small but definite keel (n), scale bar = 20 µm; 6, elongated intercostal long cells, stomata obscured by flanges (s), scale bar = 5 µm. 7, *Ellis 708* with elongated stained and unstained intercostal long cells with slightly undulating walls, microhairs (n) and flanged stomata (s), scale bar= 5 µm. 8, *Ellis 1152*; note silica bodies, costal and intercostal prickle hairs (p), stained and unstained long cells, microhairs (n) and flanged stomata, scale bar = 5 µm.

Abaxial epidermis

Costal and intercostal zones are always distinguishable (Figures 5.6–5.8, 6.2, 6.4, 7.2, 7.4–7.6). Cell size and shape differ markedly between these two zones on all the specimens examined. The intercostal long cells are often much more elongated than in *E. villosa* but this character is variable with Figures 5.6, 5.7 and 6.4 representing the two extremes encountered in this species. The long cell shape is usually rectangular but may be diamond-shaped (Figure 7.4). The markedly elongated long cells may also stain with safranin (Figures 5.7, 5.8).

Stomata occur in 2–3 files on either side of each costal zone but are absent from the central files of the intercostal zones. These stomata are always sunken and overlapped by cuticular flanges although these are not always easily visible with the light microscope (Figures 5.6, 5.7). The specimens with thinner leaves and elongated long cells have less conspicuous flanges associated with more superficial stomata. Those specimens tending toward *E. villosa* in leaf anatomy have this characteristic well developed (Figures 6.2, 6.4), as do the specimens showing similarities with the Calycina group (Figure 7.4) or the Ramosa group (Figures 7.5, 7.6). Although variable, this attribute is evident on all the specimens studied and is confirmed by the SEM (Figures 4.5–4.7).

Costal silica bodies are generally well differentiated, being conspicuous and rounded and alternating along the costal files (Figures 5.8, 6.4, 7.2). Crescent-shaped, enfolding cork cells do not appear to occur in this species. Abaxial costal prickles are common and were observed on all specimens with two specimens *(Ellis 1152* and *5102)* even possessing large intercostal prickles associated with the stomatal bands (Figure 5.8). Microhairs, although very small, were detected on all specimens, even those resembling *E. villosa* in other anatomical characteristics. Ultrastructurally these hairs are seen to have a tapering distal cell (Figures 4.6, 4.8).

Specimens examined

CAPE.—3118 (Vanrhynsdorp): Vanrhynsdorp Dist., Gifberg (–DD), *Ellis 5102.* 3119 (Calvinia): Nieuwoudtville Dist., Van Rhyn's Pass (–AC), *Ellis 1145, 4626.* 3218 (Clanwilliam): Clanwilliam Dist., Pakhuis Pass (–BB), *Ellis 1700*; Langvlei Valley, Sandberg Station (–BC), *Ellis 4642*; Piketberg Dist., Versveld's Pass (–DD), *Ellis 5130.* 3219 (Wuppertal): Cedarberg, Pakhuis Pass (–AA), *Ellis 708, 1152, 4633, 4635*; Kouebokkeveld, Skurweberg, Op-die-Berg (–CD), *Ellis 4648.* 3318 (Cape Town): Malmesbury Dist., Paardeberg (–DB), *Boucher 4724.* 3321 (Ladismith): Langeberge, Cloete's Pass, Bergkloof (–DC), *Ellis 4693.*

Comments

The diagnostic anatomical attributes of the Villosa group are all present in *E. thunbergii* although they may be somewhat modified on some specimens.

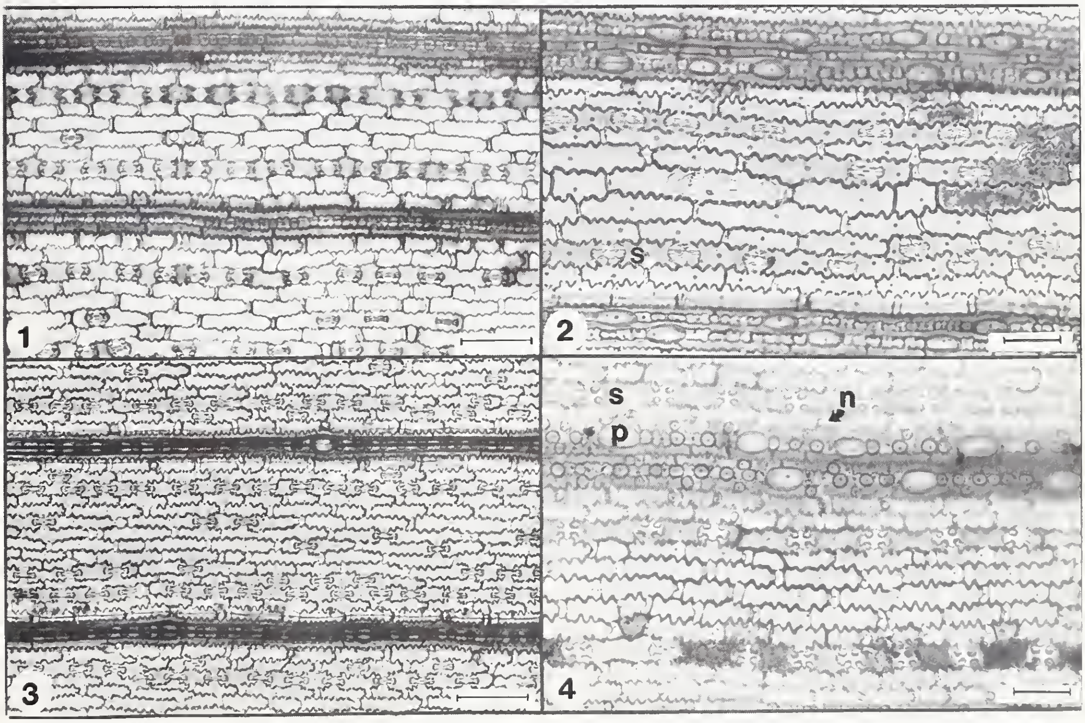

FIGURE 6. — A comparison of the abaxial leaf epidermis of *Ehrharta villosa* (1 & 3) and *Ehrharta thunbergii* (2 & 4). 1, *E. villosa, Ellis 4640,* showing short intercostal long cells with slightly sinuous walls; microhairs and prickles absent, scale bar = 10 μm. 2, *E. thunbergii, Ellis 4635,* with very sinuous long cell walls, intercostal microhairs and costal prickles, scale bar = 5 μm. 3, *E. villosa, Ellis 1651,* short, slightly sinuous long cells, flanged stomata, scale bar = 10 μm. 4, *E. thunbergii, Ellis 4648,* prominent, round costal silica bodies and prickles. Intercostal microhairs (n) and stomata (s) overarched by flanges from interstomatal long cells, scale bar = 5 μm.

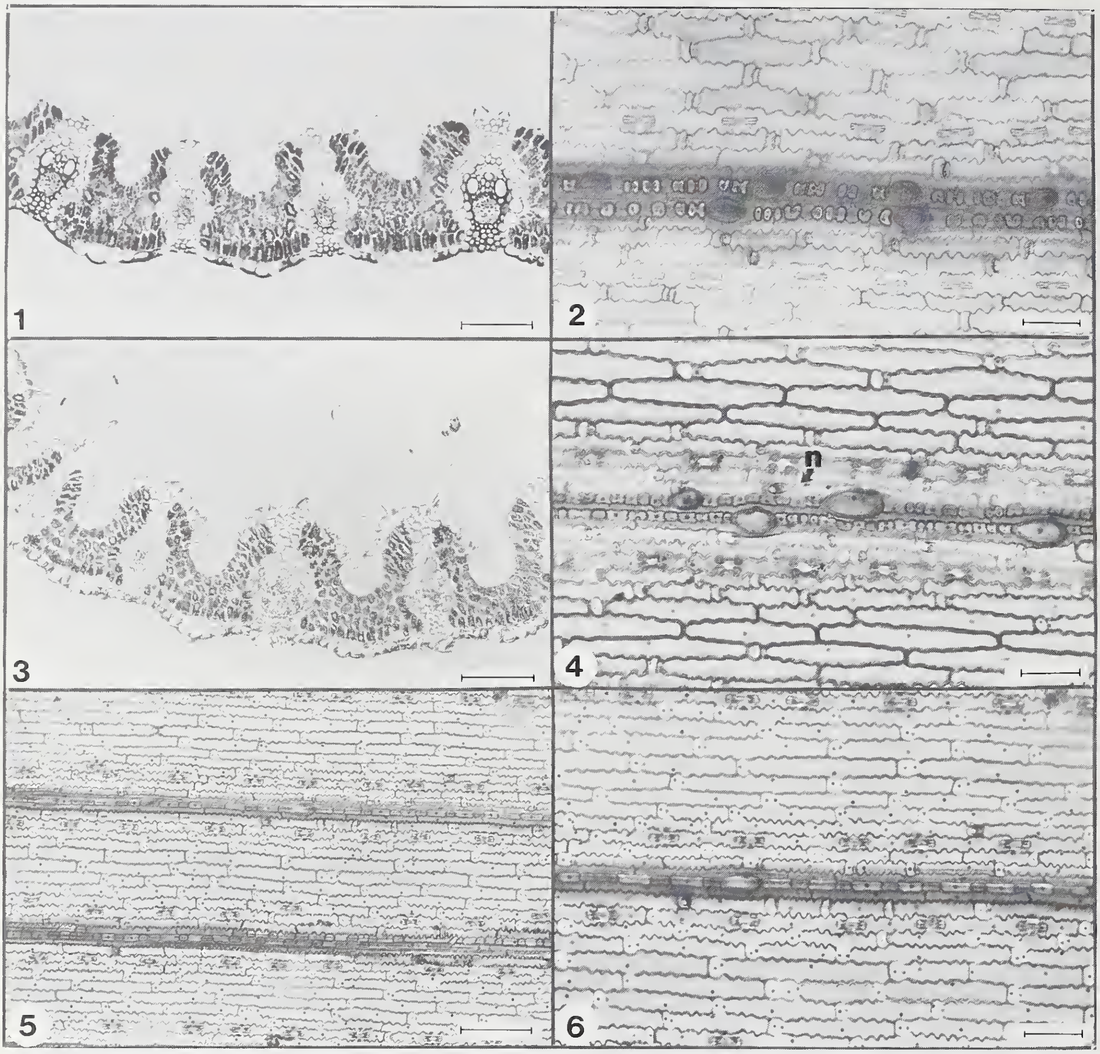

FIGURE 7. — Anatomical variation in *Ehrharta thunbergii*. 1–2, *Ellis 1700* resembling *E. villosa*: 1, transverse section with radiate and palisade-like mesophyll cells, scale bar = 10 µm; 2, abaxial epidermis with rectangular, sinuous-walled long cells but stomatal flanges not conspicuous, scale bar = 5 µm. 3–4 *Ellis 4626* resembling the Calycina group: 3, normal transverse section but note the enlarged abaxial epidermal cells in the centres of the intercostal zones, scale bar = 10 µm; 4, central intercostal long cells markedly elongated and diamond-shaped but stomata retain characteristic flanges, scale bar = 5 µm. 5–6, *Ellis 4693* resembling the Ramosa group: 5, conspicuous intercostal short cell pairs separate successive long cells, scale bar = 10 µm; 6, nucleate epidermal long and short cells but stomata flanged, scale bar = 5 µm.

Thus only a median vascular bundle is normally present but in a few specimens additional colourless parenchyma is associated with the median bundle, which, by definition, constitutes a slight keel. The semi-radiate adaxial, and palisade-like abaxial mesophyll, so characteristic of this group, is evident in most specimens. However, in a few, particularly those with thinner leaves and with abaxial intercostal ribs, this pattern may be modified slightly. In all specimens the stomata are sunken and overlapped by four papillate epidermal flanges. However, in those specimens with elongate intercostal long cells the stomata may be almost flush with the level of the epidermis and the flanges are tiny. These diagnostic features are common to all taxa of the Villosa group and serve to unite *E. villosa* and *E. thunbergii* in a group separated from all the other species of *Ehrharta*.

In addition, several characters serve to separate *E. thunbergii* from *E. villosa*, although this distinction is not very clear-cut. Examples are the presence of microhairs and abaxial prickles, both of which are lacking in *E. villosa*. The costal silica bodies of *E. thunbergii* are also well differentiated and plentiful and alternate with costal short cells. They are not associated with cork cells as in *E. villosa*. These two taxa can, therefore, be distinguished anatomically.

Yet other attributes intergrade between the taxa of this species group, and the leaf anatomy of the *E. thunbergii* specimens studied shows a certain degree of variation. A distinct gradation is evident from

those specimens closely resembling *E. villosa* (Figures 6.2, 6.4, 7.1, 7.3) to the extreme type with thinner leaves and elongated long cells (Figures 5.3–5.7). The interface with *E. villosa* is indistinct. A continuum is discernible from those specimens resembling *E. villosa* to the extreme specimens which may display characteristics of some of the other *Ehrharta* species groups, the Calycina group in particular. Calycina type features observed are the fusiform intercostal long cells as in Figure 7.4, the tendency to stain with safranin (Figures 5.6–5.8) and the intercostal abaxial ribs (Figure 5.4) or the inflated central cells of the intercostal zones as illustrated for *E. villosa* (Figures 2.4, 2.5). A single specimen, *Ellis 4642,* although not illustrated, resembles *E. calycina* particularly closely, even having straight-walled fusiform long cells and intercostal macrohairs which were not observed on any other *E. thunbergii* specimen. However, flanged stomata indicate the true identity of this specimen.

One other interesting and deviant specimen is *Ellis 4693* (Figures 7.5, 7.6) which shows similarities with the Ramosa group of species. The sinuous, rectangular long cells, all separated by conspicuous cork/silica cell pairs and the irregular, dumbbell-shaped silica bodies, are reminiscent of the Ramosa group and were not seen in any other *E. thunbergii* specimens. However, this specimen also has distinctly flanged stomata.

The anatomical sample examined in this study is heavily biased toward the north-western parts of the distribution range of *E. thunbergii.* Those specimens from high altitudes in the extreme north at Van Rhyn's Pass *(Ellis 1145,* Figures 5.5, 5.6; *Ellis 4626,* Figures 7.3, 7.4) show anatomical similarities with *E. calycina.* A specimen *(Ellis 4642)* from lower altitude in the strandveld at Langvlei resembles *E. calycina* very closely indeed. On the other hand, few specimens from the east have been classified as *E. thunbergii* (these being mainly identified as *E. villosa)* and *Ellis 4693* from Cloete's Pass in the eastern Langeberge resembles the Ramosa group in certain respects. These observations may reflect transitions to these other *Ehrharta* species groups but a much more representative sample must be studied before this can be confirmed. Nevertheless, this does serve to demonstrate that the Villosa group is not discrete, and that characteristics of some other groups are evident, as is the case throughout the genus.

These observations are largely in agreement with the findings of Engelbrecht (1956) and the few exceptions noted will be briefly discussed. For the majority of specimens the epidermis is described as being homogenous with costal and intercostal zones not being distinguishable (Engelbrecht 1956). In the present study the condition is described where these zones are structurally identical, as in *E. villosa* var. *maxima* for example, but are distinguishable on account of their differential staining. Different staining procedures, therefore, may account for this apparently superficial difference between the findings of these two studies. Engelbrecht (1956) does record the absence of microhairs and prickles associated with the homogenous type of epidermis (which appears to be homologous with *E. villosa)* whereas the epidermis with distinct epidermal zonation was associated with the presence of these hairs. This correlation was observed in the present study and is considered to be a specific difference between *E. villosa* and *E. thunbergii* but Engelbrecht (1956) did not attribute any taxonomic significance to it. He also records cuticular stomatal flanges for all the specimens he examined and notes the uniqueness of this feature in the genus.

DISCUSSION AND CONCLUSIONS

The three taxa of the Villosa group, share a distinctive leaf anatomy characterized by a unique combination of attributes as well as similar vegetative morphology and a specific habitat. These distinguishing features correlate with the diagnostic large, hairy spikelets, and their assignment to the same small species group appears to be fully justified by the anatomical as well as the morphological evidence (Gibbs Russell 1987). This group also appears to represent a natural grouping.

The leaf anatomy is characterized by the absence of a keel, palisade-like mesophyll abaxially located, rectangular long cells and stomatal apertures which are overlapped by four cuticular flanges projecting from the two adjacent interstomatal long cells. This latter feature is unique to this species group in the genus *Ehrharta.*

Although Engelbrecht (1956) studied only unifixed leaf blade material he noted that the form of the cells of the abaxial chlorenchyma layer differed from the remainder, an observation confirmed in this study. However, he also reports cell wall invaginations as being present and characteristic of *E. villosa.* These invaginations were not observed on all chlorenchyma cells, however, but appeared to be confined to those cells adjacent to the vascular bundles or adjoining the adaxial epidermis. This observation was not confirmed in the present study, in which field-fixed material was examined, and appears to be an artefact probably resulting from imperfect rehydration of the mesophyll tissue.

Engelbrecht (1956) recognized two basic groups of species in *Ehrharta* — one with invaginated chlorenchyma and one without. *E. villosa* is placed in the group with invaginations together with taxa of the Setacea and Ramosa species groups as here constituted (Gibbs Russell & Ellis 1987). The present findings are in disagreement with Engelbrecht's (1956) grouping, as the Setacea group is the only group in which arm cells were observed (Ellis 1987) and the Setacea and Villosa groups are not considered to be closely related.

Although he examined a large sample, Engelbrecht (1956) was unable to distinguish *E. villosa* and *E. thunbergii* either anatomically or morphologically and concluded that they do not represent two separate species. The present study is not in full agreement with this conclusion as *E. villosa* and *E. thunbergii* were found to differ in several respects such as the presence of microhairs and prickles as well as differences in silica bodies. Although these differences appear to be consistent and diagnostic, it must be remembered that the interface between

these two species is not distinct as far as most other characters are concerned and a continuum is evident between them without clear character disjunctions. *E. villosa* and *E. thunbergii,* therefore, intergrade to a certain extent and, although their extremes are anatomically quite distinct, a small proportion of specimens are somewhat intermediate. The decision to consider these two taxa as being conspecific (Chippindall 1955; Engelbrecht 1956), therefore, has some merit. However, the placing of *E. thunbergii* in synonomy under *E. villosa* results in a very variable, polymorphic entity with a wide ecological tolerance. The recognition of three taxa seems to be a more practical solution which probably reflects the natural situation more accurately. However, a cline undoubtedly exists from *E. villosa* var. *maxima* through var. *villosa* to *E. thunbergii* with each of these taxa occupying slightly different habitats and differing in morphology and leaf anatomy.

The relationships of the Villosa group to the rest of the genus are not very clear from anatomical evidence alone. The group does not occupy such an isolated position within the genus as does the Setacea group (Ellis 1987) which possesses such taxonomically significant diagnostic features as arm cells and distinct microhairs and silica bodies. There are also no anatomical intermediates between the Setacea group and any of the other species groups. Although the Villosa group is readily diagnosed by its flanged stomata, this feature cannot be accorded the high taxonomic value that arm cells and microhair and silica body shape have in the classification of the Poaceae, because it is encountered independently in different subfamilies.

In addition, several *E. thunbergii* specimens display strong Calycina group attributes in their leaf anatomy, and both these groups have very similar microhairs. The Villosa and Calycina groups also share very similar hairy spikelets, which differ mainly in size and profuseness of vesture, but occur in no other *Ehrharta* species group. The indications are, therefore, that the Villosa group is more closely related to the Calycina group than to any of the other groups. However, as is common in this genus, a reticulate pattern of relationships can be expected and Ramosa group characteristics were also observed on a few specimens.

The Villosa group, although distinct in morphology, anatomy and ecology, does show certain affinities with the Calycina group and undoubtedly belongs to the genus *Ehrharta.* This group, therefore, appears to be a specialized perennial line with strong underground rhizomes and suffrutescent culms which has become adapted to a sandy habitat.

ACKNOWLEDGEMENTS

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Phytogeography of the subtribe Leipoldtiinae (Mesembryanthemaceae)

H. E. K. HARTMANN*

Keywords: ecology, Leipoldtiinae, Mesembryanthemaceae, phytogeography, winter rainfall

ABSTRACT

An investigation of distribution and species frequency of the nine genera of the subtribe Leipoldtiinae shows that two centres of diversity can be distinguished. These coincide more or less with the 'Gariep centre' in the north and the 'Vanrhynsdorp centre' in the south (both sensu Nordenstam 1969). Speciation seems to have occurred in both centres. The subtribe may have evolved in an arid winter rainfall area which could have been situated outside its present distribution area. The centres of distribution coincide with those observed in both subfamilies of the Mesembryanthemaceae.

UITTREKSEL

'n Ondersoek na verspreiding en spesie-frekwensie van die nege genusse van die subtribus Leipoldtiinae toon dat twee sentrums van diversiteit onderskei kan word. Hierdie twee kom min of meer ooreen met die 'Gariepsentrum' in die noorde en die 'Vanrhynsdorpsentrum' in die suide (albei sensu Nordenstam 1969). Dit wil voorkom asof spesiasie in albei sentrums plaasgevind het. Die subtribus kon moontlik in 'n dorre winterreëngebied wat buite die huidige verspreidingsgebied geleë kon gewees het, ontwikkel het. Die verspreidingsentrums kom ooreen met dié wat in albei subfamilies van die Mesembryanthemaceae waargeneem is.

INTRODUCTION

The subtribe Leipoldtiinae of the Mesembryanthemaceae comprises nine genera with a total of 81 species. Members of the subtribe can be recognized by their rather hard xeromorphic leaves (the outer epidermal wall always contains calcium oxalate crystals) and their multilocular capsules (Figure 1) with valve wings, closing bodies and complete covering membranes. These membranes are distally recurved and radially traversed by a trace of spongy tissue which distally forms an additional closing device (closing bulge, ledge or rod, Hartmann 1983c). Dissemination depends directly on the described internal structure (Funktionstyp 1 after Hartmann 1983c) and is effected in most taxa only by rain drops.

This is the first analysis of its kind within the Mesembryanthemaceae because this is the first group of genera for which adequate data are available. The phytogeography of the subtribe is of particular interest for two reasons: the distribution area of the Leipoldtiinae coincides with the centre of distribution of the entire family; and within this area, members of the subtribe form a major part of the vegetation.

METHODS AND MATERIAL

The investigation is based on numerous field studies carried out between 1977 and 1986, about 6 000 relevant collections and about 800 additional herbarium sheets. Ecological data are derived partly from literature and partly from own observations; rainfall data were provided by the Weather Bureau, Pretoria. Information concerning morphology, anatomy, evolution and detailed distribution are taken from the relevant genus monographs (see References).

RESULTS

Distribution of the subtribe

The subtribe is confined to the south-western Cape. Only one genus *(Cephalophyllum)* occurs in the entire range of the subtribe (see Figure 2), the other genera are restricted to smaller areas. The frequency distribution of genera is consequently uneven (Figure 3). Two main centres can be distinguished, a southern one, which will be referred to as 'Vanrhynsdorp centre' (sensu Nordenstam 1969), and a northern one, which agrees largely with the 'Gariep centre' (sensu Nordenstam 1969). These centres stand out even more prominently when species distribution (Figure 4) is considered, and their significance will be discussed below.

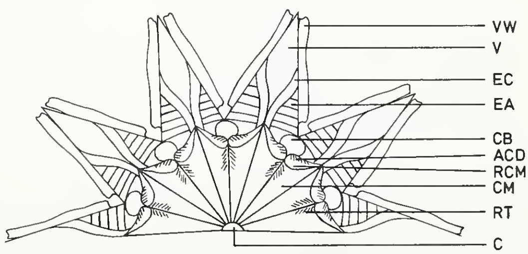

FIGURE 1. — Open fruit of Leipoldtiinae, schematic. ACD = additional closing device; C = columella; CB = closing body; CM = covering membrane; EA = expanding area; EC = expanding keel; RCM = recurved distal portion of covering membrane; RT = radial trace of spongy tissue; V = valve; VW = valve wing.

* Institut für Allgemeine Botanik, Universität Hamburg, Ohnhorststrasse 18, D-2000 Hamburg 52, West Germany.

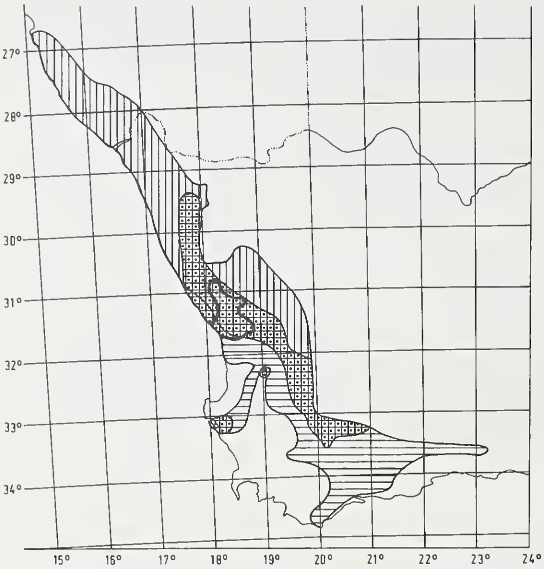

FIGURE 2. — Distribution areas of *Cephalophyllum* (thin lines) and *Argyroderma* (bold line). Horizontal lines = *Cephalophyllum* subgenus *Cephalophyllum*; vertical lines = *Cephalophyllum* subgenus *Homophyllum*; overlapping areas dotted.

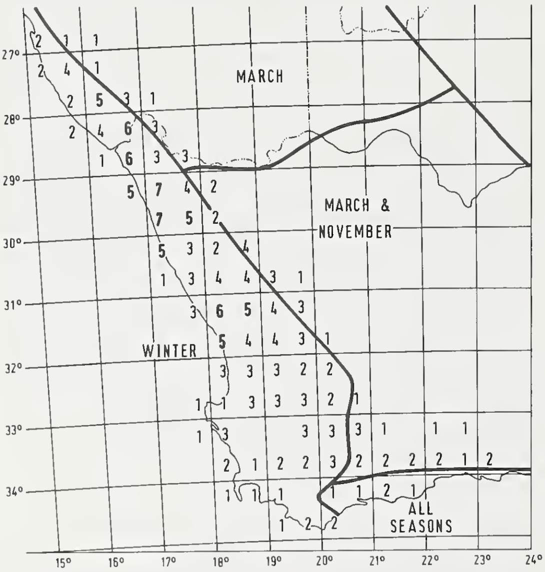

FIGURE 3. — Frequeney of genera of Leipoldtiinae (N = 9) per 30′ × 30′ square. Two centres can be distinguished: 'Gariep centre' (bold figures between latitudes 27° and 31°); 'Vanrhynsdorp centre' (bold figures between latitudes 31° and 32°). Bold lines delineate the four main rainfall areas of the region.

The eastern limit of the distribution area of the Leipoldtiinae coincides for most of its extension with the eastern boundary of the winter rainfall area (defined here as the region receiving at least 60% of its annual precipitation between April and September, Figure 3). Only in the south, three genera *(Cephalophyllum, Jordaaniella* and *Leipoldtia)* extend considerably into the March/November or all season rain-

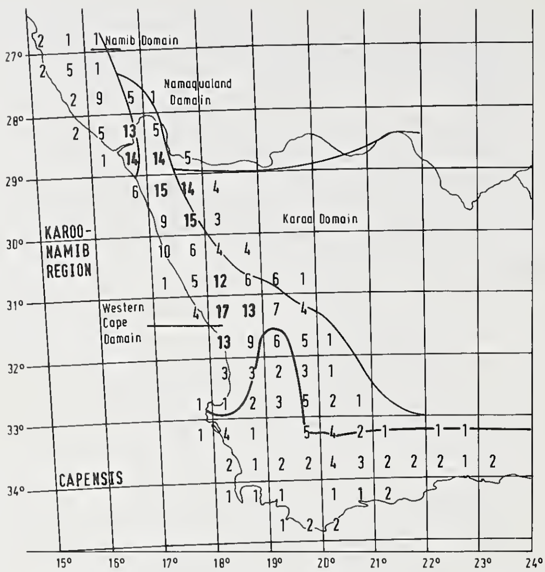

FIGURE 4. — Frequency of species of Leipoldtiinae (N = 81) per 30′ × 30′ square. The same two centres as in Figure 3 stand out (bold figures).

fall areas. Only two species out of the 81 have their centre of distribution outside the winter rainfall region: *Cephalophyllum subulatoides* (Haw.) N.E. Br. (southern Little Karoo, 33°30′S, 21°–23°E) and *Cheiridopsis caroli-schmidtii* (Dinter & Berger) N.E. Br. (near Aus, 27°S, 16°E). The amount of annual precipitation decreases in the distribution area from south to north, and less markedly from west to east (Figure 5).

Phytochorologically, the main concentration of taxa falls into the Western Cape Domain of the Karoo-Namib Region as defined by Werger (1978), with extensions into the Namib Domain in the north, into the Karoo Domain in the north-east and even into Capensis in the south (Figure 4). Only a few species have their centre of distribution in Capensis sensu Werger (1978), namely *Cephalophyllum diversiphyllum* (Haw.) H. E. K. Hartm., *C. loreum* (L.) Schwantes, and *C. subulatoides* (Haw.) N.E. Br.

Distribution of genera

Cephalophyllum

The largest genus of the subtribe, *Cephalophyllum* N.E. Br., with 30 species, has the largest distribution area (Figure 2) and grows in a wide range of ecological situations, from coastal to high mountain habitats, from monotypic open succulent associations to undergrowth in fynbos, and from the highest to the lowest rainfall regimes in different seasons. The two subgenera have different centres of distribution (Figure 2): subgenus *Cephalophyllum* dominates in the south and subgenus *Homophyllum* in the north, with a wide corridor in which they overlap.

A species frequency analysis (based on numbers of species per 30′ × 30′ square) reveals that the highest number of species occurs in the Vanrhynsdorp centre (Figure 6), which lies in the zone of overlap of the subgenera (Figure 2). A second centre of species

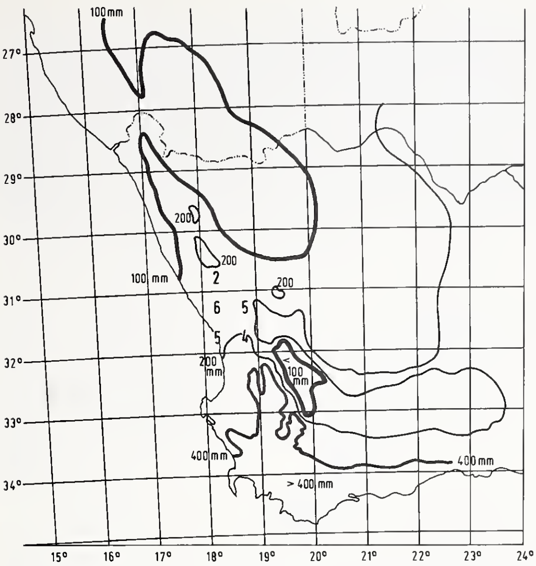

FIGURE 5. — Frequency of species of *Argyroderma* (N = 10) per 30′ × 30′ square and selected isohyets (bold line = 100 mm; medium line = 400 mm; thin line = 200 mm).

frequency lies in the north and coincides with the Gariep centre of the subtribe (Figure 3). These centres cannot be correlated directly with the subgenera, as the centre of subgenus *Cephalophyllum* is situated near 33°S, 20°E (Figure 6 and Hartmann in press). In spite of the high species numbers per square, sympatry in *Cephalophyllum* is rare and speciation has been predominantly allopatric (Hartmann in press). Twelve species (40%) can be considered endemic: they occur in one to three 30′ squares only (Figure 6). They are found near the two species centres but their frequency is low (1–3 per 30′ square).

Consequently, *Cephalophyllum* can be described as a genus with mostly widespread yet vicariant species, which have become adapted to a wide range of edaphic and climatic conditions: the genus occurs in 13 different vegetation types as defined by Acocks (1975) (Hartmann in press). The extended distribution area reflects the high degree of adaptability of the genus even today, supporting the hypothesis that the genus is at present in an active evolutionary phase (Hartmann in press).

Argyroderma

Closely related to *Cephalophyllum* is the genus *Argyroderma* N.E. Br. (Hartmann 1983c, in press) with ten species (Hartmann 1978a), restricted in distribution to the Knersvlakte in the Vanrhynsdorp centre (Figure 2), with a maximum of six species per 30′ square (Figure 5). In contrast to *Cephalophyllum, Argyroderma* therefore presents a genus of narrow distribution which is due to the strict adaptation to the unique edaphic mosaic of the Knersvlakte.

Leipoldtia

With only eight species, *Leipoldtia* L. Bol. is one of the smaller genera of the subtribe, yet it is one of wide distribution (Figure 7). The predominantly shrubby plants often grow in conspicuous patches, mostly on gravelly and flat sedimentary soils. In contrast to the wide occurrence of subgenus *Leipoldtia,* the subgenera *Aureae* and *Cephalophylloides* inhabit only restricted areas overlapping with that of subgenus *Leipoldtia* (Figure 7). Only one species *(L. frutescens,* of the subgenus *Aureae)* grows in coastal plains (Strandveld sensu Acocks 1975). All other taxa inhabit higher altitudes, mainly in Namaqualand Broken Veld, Western Mountain Karoo and Karroid Broken Veld of the Little Karoo.

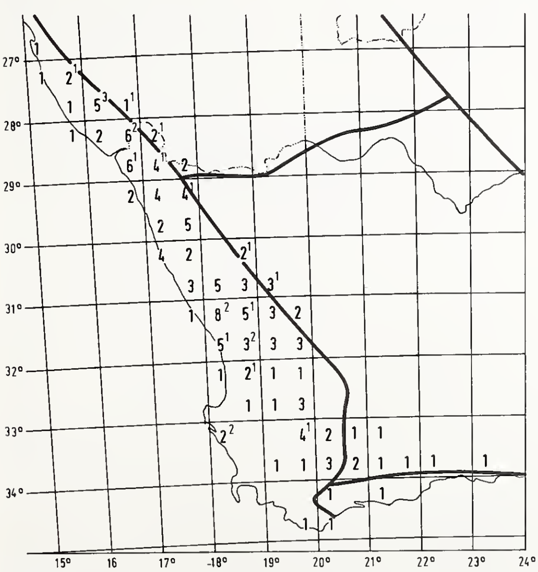

FIGURE 6. — Frequency of species of *Cephalophyllum* (N = 30) per 30′ × 30′ square. Small figures indicate frequency of endemic species.

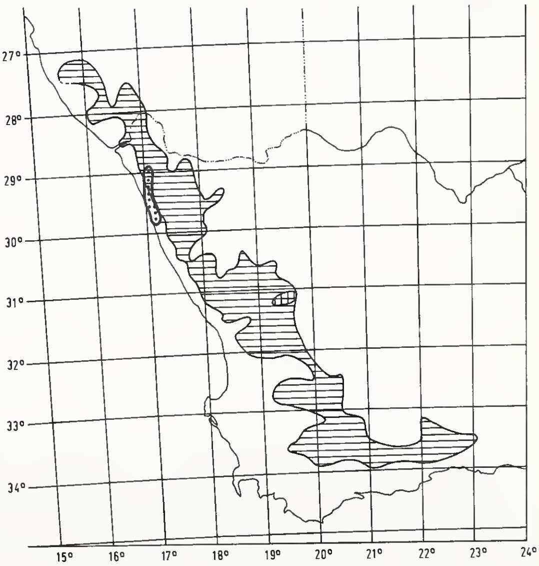

FIGURE 7. — Distribution area of *Leipoldtia.* Horizontal lines = subgenus *Leipoldtia;* vertical lines = subgenus *Cephalophylloides;* dots = subgenus *Aureae.*

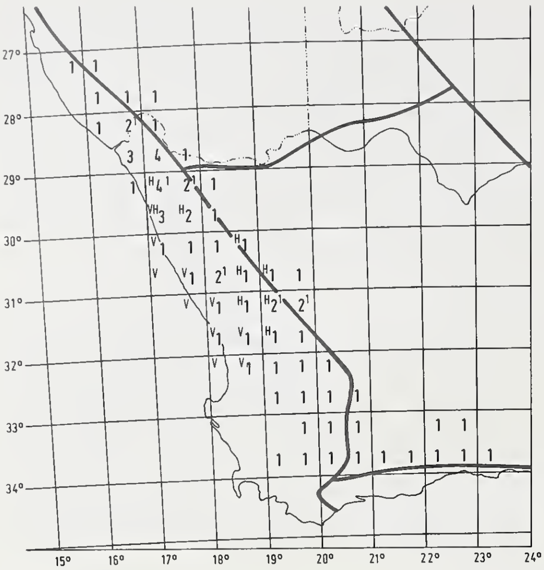

FIGURE 8. — Frequency of species of *Leipoldtia* (N = 8) per 30′ × 30′ square. H = occurrence of *Hallianthus;* V = occurrence of *Vanzijlia* in the square.

The highest species frequencies are found within the southern Gariep centre (Figure 8), where in certain localities up to three species occur sympatrically, each fitting into an ecological niche slightly different from those of the others (Hartmann & Rust in prep.). Since the same species can inhabit obviously different habitats in distant areas, a fine regulation of adaptation in regard to competition and isolation can be expected, but this is not yet understood (Rust unpublished).

Although 50% of all species of *Leipoldtia* occur in one 30′ square, it cannot be simply assumed that this area presents a centre of origin. The scattered distribution of endemic species (Figure 8), and the varied character expressions in geographically separated areas of one species, point more towards an active phase of speciation by means of differentiation of semi-isolated, more or less marginal populations. The high species frequency in the Gariep centre could be the result of secondary invasions combined with the stabilization of hybrid derivatives as ecologically well adapted forms which have become isolated (Rust unpublished).

Hallianthus and *Vanzijlia*

Two monotypic genera with allopatric distribution are related to the genus *Leipoldtia* (Hartmann 1983c): *Hallianthus* H. E. K. Hartm. and *Vanzijlia* L. Bol. *Hallianthus* grows predominantly at altitudes above 300 m (Hartmann 1983b) in Namaqualand Broken Veld (sensu Acocks 1975) in associations of succulent shrubs. It extends northwards into the Gariep centre (Figure 8). *Vanzijlia,* as a mainly coastal genus, occurs around and in the Vanrhynsdorp centre (Figure 8). Most populations have been found in shrubby succulent associations of the Strandveld (sensu Acocks 1975), few inland in Succulent Karoo (Hartmann 1983a).

Cheiridopsis and *Odontophorus*

The genus *Cheiridopsis* N.E. Br. with 23 species, represents the third of the widespread genera of the subtribe. Like the genus *Odontophorus* N.E. Br., it can be recognized by its papillose leaf surface (Hartmann 1983c). As in *Cephalophyllum,* the two larger subgenera (subgenus *Cheiridopsis* and *Aequifoliae)* inhabit largely different geographical areas (Figure

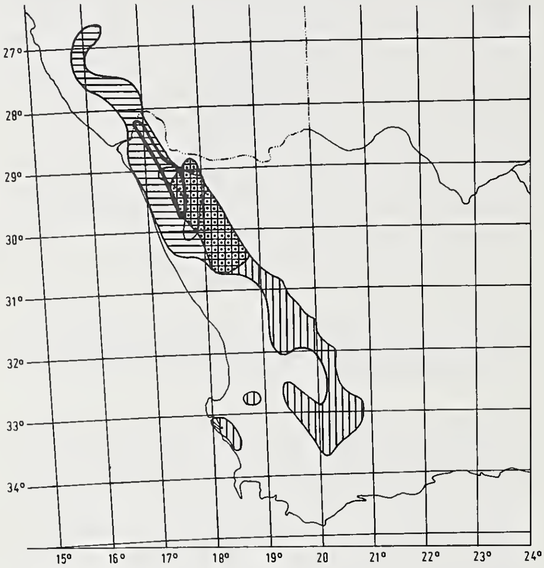

FIGURE 9. — Distribution of *Cheiridopsis* and *Odontophorus* (thin contour between latitude 28°55′ and 30°10′). Horizontal lines = *C.* subgenus *Aequifoliae;* vertical lines = *C.* subgenus *Cheiridopsis;* dots = area in which subgenera *Aequifoliae* and *Cheiridopsis* overlap; bold contour = *C.* subgenus *Odontophoroides.*

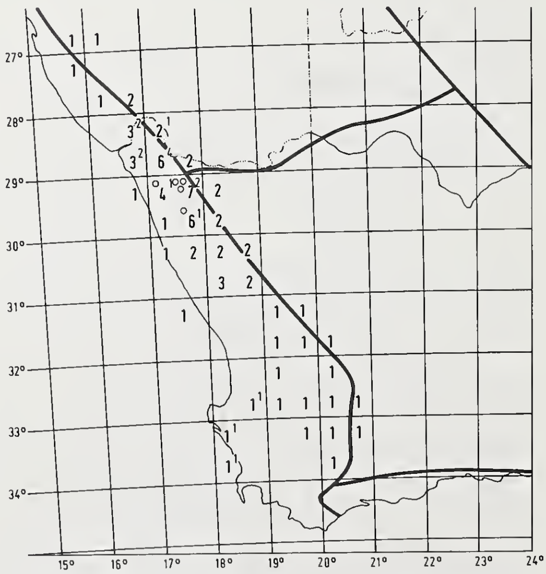

FIGURE 10. — Frequency of species of *Cheiridopsis* per 30′ × 30′ square (N = 23). Small figures indicate number of endemic species; O = *Odontophorus;* one symbol represents one species per square.

9) with an intervening zone in which they overlap. The third, smaller, subgenus *Odontophoroides,* as well as all species of the closely related genus *Odontophorus,* also occur in and near to this area of overlap. Consequently the number of species per 30′ square is high (Figure 10) and contributes substantially to the formation of the southern Gariep centre (Figure 4). Furthermore, most of the endemic species of *Cheiridopsis* (occurring in at most three adjacent 30′ squares) are found here (Figure 10).

In and around the Gariep centre, sympatry of different species of *Cheiridopsis* is frequent, but in most localities different, well defined microhabitats are colonized (Hartmann & Dehn 1987). The three species of *Odontophorus* occur allopatrically in disjunct areas (Hartmann 1976) as do the six species of subgenus *Odontophoroides* (Hartmann & Dehn 1987).

Cheiridopsis and *Odontophorus* constitute a genus pair similar in principle to *Cephalophyllum/Argyroderma* in so far as the genus of restricted distribution occurs in a centre of high species frequency of the widespread genus, but they differ in so far as *Cheiridopsis/Odontophorus* only possess one centre of diversity.

Another characteristic of the *Cheiridopsis/Odontophorus* complex is its nearly exclusive distribution along the eastern boundary of the area of the subtribe at altitudes above 300 m. Only three species, *C. brownii* Schick & Tischer and *C. robusta* (Haw.) N.E. Br. in the north and *C. rostrata* (L.) N.E. Br. in the south, occur on lower coastal plains. Nevertheless, the ecological amplitude of the genus is considerable. It occurs in eight veldtypes of Acocks (1975), with one species, *C. cigarettifera* (Berger) N.E. Br. in the south, growing in six different vegetation types (Hartmann & Dehn 1987). The adaptation to shrubby Renosterveld is particularly remarkable since this vegetation type is rather remote from Karoo types of vegetation.

Jordaaniella and *Fenestraria*

A distribution pattern different from the aforementioned ones is found in the genera *Jordaaniella* H. E. K. Hartm. and *Fenestraria* N.E. Br. (Figure 11), which are distinguished from the other genera of the subtribe by a considerable reduction of the closing body (Hartmann 1982, 1983c, 1984).

The plants grow exclusively on littoral aeolian sands, the distribution coinciding with Strandveld (sensu Acocks 1975) in the coastal fogbelt (sensu Nagel 1962) along the west coast. The occurrence along the south coast agrees well with the 'south coast Strandveld' as delineated by Moll *et al.* (1984), although the easternmost population exceeds these boundaries (Figure 11).

Only five species are recognized in the complex: one in *Fenestraria* and four in *Jordaaniella* (Figure 11). Sympatry is restricted to a section along the west coast (28°–30°30′S) with a maximum of three species near 30°S, 17°E. Both endemic species (*J. clavifolia* (L. Bol.) H. E. K. Hartm. and *J. longifolia* (L. Bol.) H. E. K. Hartm.) occur in this region, but it is doubtful whether the centre of origin lies here (Hartmann 1984).

Clearly, the limited distribution areas of both genera are due to their very narrow ecological amplitudes leaving limited scope for speciation (Hartmann 1984).

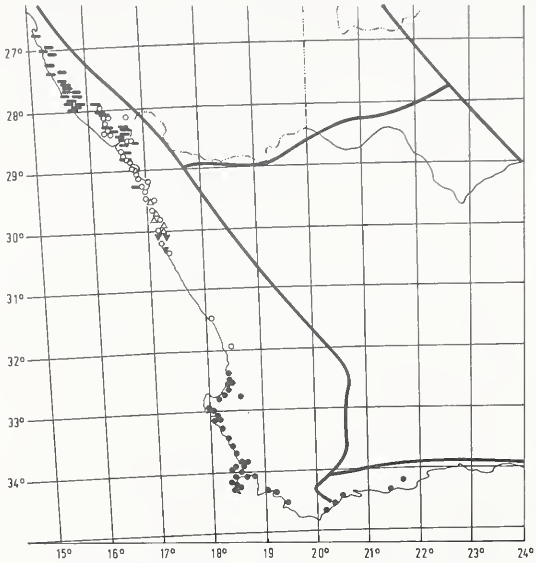

FIGURE 11. — Distribution of *Fenestraria* (solid bars) and *Jordaaniella* (open circles = *J. cuprea;* open triangles = *J. clavifolia;* full triangles = *J. longifolia;* full dots = *J. dubia).*

DISCUSSION

Interpretation of the phytogeographical data will concentrate on two different aspects: firstly the composition, development and meaning of the two geographical centres, and secondly the distribution of the genera and their possible evolution. In the process, ideas will be developed on the origin and the history of the Leipoldtiinae as a whole.

High species numbers in restricted geographical areas mostly reflect wide ecological diversity, and two processes can be distinguished: 1, specialization *in situ,* which can be recognized by a high percentage of endemic taxa; 2, overlapping of distribution areas of species which have their main (mostly wide) extension outside the centre of diversity; in the centre itself they colonize the ecologically and/or geographically extreme habitats to which they are adapted.

In the first case close relationship between the taxa is common, whereas in the second, relationship is irrelevant, the effect being simply accumulative. In both centres of multiplicity of the Leipoldtiinae, a core of closely related species, including several endemics, is found (Figures 2, 5–11). In the Gariep centre, the genera *Cephalophyllum* (Figure 6) and *Cheiridopsis* (Figure 10) represent the major portion (60–70%) of the occurring species. In the Vanrhynsdorp centre, species of *Cephalophyllum* (Figure 6)

and *Argyroderma* (Figure 5) contribute largely to the formation of the centre (up to 14 out of 17 species in one 30′ square). Of the additional taxa occurring in these centres, some clearly reach the limit of their distribution here: *Vanzijlia* and *Hallianthus* in the Vanrhynsdorp centre (Figure 8); and *Hallianthus* (Figure 8), *Jordaaniella* and *Fenestraria* (Figure 11) in the Gariep centre.

Obviously, in both centres speciation and overlapping of distribution areas contribute to the high degree of diversity, and it can be suggested that several subsequent events contributed to bring about the present situation. A similar case has been reported in the eastern Cape, for which Gibbs Russell & Robinson (1981) stress the accumulative effect of different phytochoria meeting, whereas Cowling (1982) points out certain groups with high endemism.

Both centres of the Leipoldtiinae exhibit extreme variation in geology and soils, often in island pattern distribution, a condition considered favourable for speciation of semi-isolated populations. In addition, the dense mosaic of different ecological niches in both centres permits short-distance migration under changing climatic conditions, thus allowing persistence of taxa within the area.

Consequently, it is not surprising that both phytogeographical centres have been traced in other groups as well (e.g. Nordenstam (1969) who named the Vanrhynsdorp centre, and circumscribed a 'Gariep centre' in the north). Of the two, the less prominent Vanrhynsdorp centre seems the more uniform, its undulating surface suggesting differentiation mainly in edaphic factors (e.g. Nordenstam 1969). Yet, on close investigation a wealth of ecological niches is found and is reflected in the vegetation (Jürgens 1986).

The Gariep centre has been accepted more readily as a phytogeographical centre because its geological differentiation is complimented by a large relief formation into which the extensions of the surrounding widespread plains reach (e.g. Tölken pers. comm.; Nordenstam 1969; Goldblatt 1976; Moffett 1979). The Gariep centre of the Leipoldtiinae covers a wider area (Figures 3 & 4) than the one circumscribed by Nordenstam (1969) and receives varying amounts of annual precipitation. It is not surprising, therefore, that not a single species occurs over the entire range. Distinct subcentres of genera can be seen: In *Cephalophyllum* (Figure 6), species numbers decrease from northwest to southeast, in *Cheiridopsis* (Figure 10) an increase occurs in the same direction, and *Leipoldtia* has its highest species frequency in the two central 30′ squares (Figure 8). Yet, it seems impossible to subdivide the centre into smaller entities, and it seems possible that within the area migration movements could have taken place.

Six species of five genera occur in both phytogeographical centres: *Cephalophyllum inaequale* L. Bol., *Cephalophyllum pillansii* L. Bol., *Hallianthus planus* (L. Bol.) H. E. K. Hartm., *Jordaaniella cuprea* (L. Bol.) H. E. K. Hartm., *Leipoldtia schultzei* (Schltr. & Diels) Friedrich and *Vanzijlia annulata* (Berger) L. Bol. As can be expected, all of them have their main distribution areas outside the centres, thus contributing to the 'overlapping effect' (see above).

All nine genera have different distribution patterns, and three main types can be distinguished: A — restricted distribution, B — wide distribution with one distinct centre, C — wide distribution without a distinct centre.

The genera *Argyroderma* (Figure 5) and *Odontophorus* (Figure 9) represent examples of pattern A and their restricted geographical occurrence is correlated with marked ecological adaptations (Hartmann 1976, 1978a).

Edaphic factors seem to play important roles in both genera, indicating that speciation may have occurred in the present areas of distribution. This would suggest that appropriate climatic conditions have prevailed for a considerable period allowing extensive radiation processes to take place.

A genus of wide distribution with one distinct centre of diversity (pattern B) is *Cheiridopsis,* where highest species numbers and occurrence of all three subgenera coincide (Figures 9 & 10). Based mainly on morphological data, Hartmann & Dehn (1987) suggest that the centre of origin of the genus (and of the closely related genus *Odontophorus)* lies here, speciation having been promoted by the varied ecological conditions within the southern Gariep centre (see above). Marginal speciation (via semi-isolated populations) in extreme habitats seems to have been rare and has been recorded for *Cheiridopsis carolischmidtii* (Dinter & Berger) N.E. Br. in the north on weathered gneiss in the March rainfall area, and *Cheiridopsis rostrata* (L.) N.E. Br. in the south-west on sandy soils in West Coast Strandveld (sensu Moll *et al.* 1984). *Leipoldtia* can be taken as another example of distribution pattern B, but the centre is less prominent and marginal speciation (Figure 8) more frequent — both smaller subgenera colonize the border areas. The genus could therefore also be seen as an example of pattern C, which lacks a distinct centre. The predominantly shrubby habit and generally low expression of succulence in leaf, stem and root indicate that *Leipoldtia* may have evolved under slightly wetter conditions than it experiences today, perhaps even outside its present distribution area.

The widespread monotypic genera *Fenestraria* (Figure 11), *Hallianthus* and *Vanzijlia* (Figure 8) naturally lack centres of species richness, and even surveys for character multiplicity (Hartmann 1982, 1983a, 1983b) have not yielded positive results. Differentiation patterns can be correlated with geographical distribution (flower characters in *Fenestraria,* Hartmann 1982) or ecological factors (germination in *Vanzijlia,* Hartmann 1983a) or they can occur incidentally (flower characters in *Hallianthus* with island-type distribution, Hartmann 1983b). Adaptation to rocky habitats restricts the distribution of *Hallianthus.* The genus could well have occurred over wider conjunct areas at a time when sedimentary plains covered less ground.

Assessment of the widespread genus *Jordaaniella* is complicated by the strict adaptation to coastal habitats (Figure 11) over several climatic ranges. Ex-

tensive migration along the coast could have taken place, and although three of the four species occur in close proximity (near 30°S, 17°E, Figure 11) it does not seem justified to conclude that this region is the centre of origin (see also Hartmann 1984). Nevertheless, the creeping habit and prolonged germination indicate that the genus probably originated in a coastal habitat.

The large genus *Cephalophyllum* exhibits a complex distribution pattern which cannot be assigned to one of the types mentioned above. Following the character analyses of Hartmann (1978b, in press), the most primitive capsule types and least specialized growth forms occur in species in the Vanrhynsdorp centre, where the highest species frequencies of the genus are found as well (Figure 6). But the number of endemics is low, suggesting that the present species richness is mainly due to overlapping of distribution areas.

In contrast, the species of the Gariep centre show a high degree of uniformity in capsule morphology, differing mainly in habitat and seed characters, so that this region can be considered to represent a centre of origin for part of the genus (Hartmann in press).

In contrast to *Cheiridopsis* (above), relations between the two subgenera cannot be elucidated from distribution data alone (Figure 2). This is mainly due to the more or less strict allopatric occurrence of the nine species of *Cephalophyllum* subgenus *Cephalophyllum,* in which highest frequencies per 30′ square (three species, Hartmann in press) are attained mainly by overlapping of wide distribution areas (only two species of restricted distribution are known, one of them isolated in the south-west, see Figure 6). Speciation in this subgenus seems to have followed predominantly the parapatric model (sensu Wiley 1981) in which narrow contact zones existed between diverging populations.

Some speculations can be made on the phytogeographical development of *Cephalophyllum.* The predecessor of this genus (and *Argyroderma?)* could have existed in the Vanrhynsdorp centre, but a major part of the genus would have occurred in (or migrated to ?) adjacent areas. Differentiation of the two subgenera possibly took place outside the present distribution range, probably followed by a phase of extensive geographical spreading — *Cephalophyllum* subgenus *Cephalophyllum* mainly into the wetter south, subgenus *Homophyllum* mainly into the drier north of the present distribution area. While parapatric speciation may have prevailed in subgenus *Cephalophyllum,* radiation of a considerable part of the subgenus *Homophyllum* could have taken place in the Gariep centre. Distribution pattern B (above) can be applied to this species group.

At first sight it seems improbable that a common pattern for the biogeographical development of the Leipoldtiinae can be found. But the extensive meshing of character states, as demonstrated for the subtribe by Hartmann (1983c), clearly indicates that it constitutes a monophyletic group. The area of origin cannot be deduced from present distribution data and may well have lain outside the existing range. Yet, it was probably not too far away because speciation processes are generally slow and many taxa of restricted occurrence (e.g. species of *Cheiridopsis* subgenus *Odontophoroides)* and/or with narrow ecological amplitude (e.g. *Argyroderma, Fenestraria)* can hardly be imagined to have migrated far.

With respect to ecology, the present data suggest that a winter rainfall regime with rather low annual amounts of precipitation (<200 mm, Figure 5) could have prevailed in the area of origin. The few extant exceptions could be seen as ecological fugitives. It is difficult though to localize an adequate region in the past, as opinions on past climates in South Africa are highly controversial (e.g. Van Zinderen Bakker Sr 1978; Deacon 1983), in particular with reference to the extent of the winter rainfall area (e.g. Van Zinderen Bakker Sr 1976, 1978; Lancaster 1979) in the late Pleistocene. In any case, it is accepted that higher precipitation prevailed in the west than at present (Kent & Griebnitz 1985). This leads some authors to the conclusion that the Namib is of rather recent origin (e.g. Tankard & Rogers 1978; Axelrod & Raven 1978) while others (e.g. Lancaster 1979) assume that arid ‘isolated refuges along the Namib coast’ or widespread deserts (e.g. Sarnthein 1978) existed during the wet phases of the late Pleistocene. Van Zinderen Bakker Sr (1978) also states that the Namib is ‘ancient’ and has only marginally been influenced by higher rainfall, retaining its ‘hyper-arid centre’ since the late Tertiary. An area like this could present an ideal cradle for speciation, permitting successive peripheral isolation of populations while re-migration could occur as well.

It seems possible therefore, that the predecessors of the extant genera of Leipoldtiinae originated on the fringes of an ancient Namib, probably under slightly higher rainfall regimes than today (based on the assumption that the less pronounced xeromorphic character expressions in *Leipoldtia, Cephalophyllum* and *Jordaaniella* reflect the more primitive stages). The existence of strictly coastal taxa *(Jordaaniella, Fenestraria)* suggests that similar habitats were already available during early speciation processes.

The origin of the Leipoldtiinae as a whole remains even more obscure than the diversification within the subtribe. By its unique morphological character set, the taxon is rather isolated within the family, although the xeromorphic leaf characters indicate that the closest relatives must be sought among the xeromorphic genera of the subfamily Ruschioideae. The main frequency centre of these genera lies around the mouth of the Orange River, coinciding with the Gariep centre of the Leipoldtiinae. A less pronounced centre is found in the Little Karoo, and a third minor one in the Knersvlakte (Vanrhynsdorp centre), but genera of xeromorphic Ruschioideae occur as far east at 29°E, and as far north as 26°S in almost every degree square. Leipoldtiinae colonize a restricted area within the range of the Ruschioideae, thus emphasizing the relative isolation of the group. They contribute substantially to the formation of the western frequency centres (up to 50% of genera per 30′ square), and present a typical ‘arid winter rainfall’ distribution.

The possibility cannot be excluded that this climatic regime presents the centre of origin of the xeromorphic members of the Ruschioideae, but in the absence of information from less derived subtribes no evidence can be offered for or against the suggestion.

With reference to the entire family, it may be important to note that distribution patterns of both subfamilies coincide almost completely, and that non-xeromorphic genera have their centres of frequency in the winter rainfall region as well. It can therefore be suspected that adaptation to winter rainfall with lower precipitation amounts could present a primary step of evolution within Mesembryanthemaceae, but the phytogeography of the Leipoldtiinae cannot be used as proof because of their specialized derived character set.

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Preliminary floristic analysis of the major biomes in southern Africa

G. E. GIBBS RUSSELL *

Keywords: biomes, Desert, Fynbos, Grassland, Karoo, Nama-Karoo, Savanna, species diversity, Succulent Karoo

ABSTRACT

Over 24 000 plant taxa are known to occur in the southern African flora, which is extraordinarily rich on a species/area basis. Lists of species and infraspecific taxa recorded for the six major biomes, Fynbos, Savanna, Grassland, Nama-Karoo, Succulent Karoo and Desert, were obtained from the PRECIS specimen database. These lists were analysed by numbers of unique and shared species and infraspecific taxa, by differential occurrence and life forms of large genera, and by differential occurrence of families. Each biome is floristically distinct except Nama-Karoo. The biomes form two main groupings, those with winter rainfall and those with summer rainfall. Succulent Karoo is most similar to Fynbos and Nama-Karoo is most similar to Savanna.

UITTREKSEL

Dit is bekend dat meer as 24 000 planttaksons in die suider-Afrikaanse flora voorkom, wat op 'n spesies/area-grondslag buitengewoon ryk is. Lyste van spesies en infraspesifieke taksons van die ses hoofbiome, Fynbos, Savanne, Grasveld, Nama-Karoo, Sukkulente Karoo en Woestyn, is vanaf die PRECIS-eksemplaardatabasis verkry. Hierdie lyste is ontleed in terme van unieke en gemeenskaplike spesies en infraspesifieke taksons, differensiële voorkoms en lewensvorme van groot genusse, en die differensiële voorkoms van families. Elke bioom behalwe Nama-Karoo, is floristies kenmerkend. Die biome vorm twee hoofgroeperings, dié met winterreënval en dié met somerreënval. Sukkulente Karoo toon die meeste ooreenkoms met Fynbos en Nama-Karoo toon die meeste ooreenkoms met Savanne.

CONTENTS

* Botanical Research Institute, Private Bag X101, Pretoria 0001.

INTRODUCTION

The southern African flora is extremely species-rich in terms of species/area ratios, with 0,0081 species/km^2 overall (Figure 1). This value is higher than those recorded for humid tropical floras such as Brazil (0,0044) and Asia (0,0041) (Gibbs Russell 1985b). The winter rainfall Cape Floral Kingdom is well known to be extremely species-rich (Goldblatt 1978). However, even when the Cape flora is excluded from calculation, the species/area ratio for the rest of the southern African flora (0,0061) is still considerably higher than that of the humid tropics, and nearly twice that of Australia (0,0032), which also includes both tropical and temperate areas.

These species/area ratios indicate in a superficial way that the remarkable species richness of the southern African flora is not restricted to the Cape Floral Kingdom. The aim of this study is to investigate the floristic richness of the major biomes and to explore floristic relationships between these biomes using distribution data for families, genera and species.

At the present time, the PRECIS (Pretoria National Herbarium Computerized Information System) specimen database is by far the most comprehensive source of information on the distribution of plant taxa in southern Africa. Although PRECIS has certain limitations (see Methods), this preliminary study forms a base against which more detailed studies of particular biomes can be put in context, and which will allow the generation of hypotheses to guide future studies. A re-evaluation should be done when more complete checklists, based on co-operative herbarium studies and intensive field work, have been compiled for all the biomes.

FIGURE 1. — Species/area ratios for large regions. The number of species and areas in km² for each region follow Gibbs Russell (1985b).

METHODS

This study is based on checklists compiled from PRECIS for quarter degree latitude and longitude grids representing the major biomes for southern Africa. The biomes adopted were determined by superimposing five recent treatments of southern African vegetation using floristic, structural and environmental criteria (Werger 1978; Scheepers 1982 based on Acocks 1975; White 1983; Huntley 1984; Rutherford & Westfall 1986). The resulting composite map showed six major regions that were recognized as entities, even though none of the studies agreed on exact boundaries. Elimination of all areas of disagreement, and of areas smaller than a quarter degree, yielded the regions accepted as the core biomes for this investigation (Figure 2). Important environmental characteristics of the core biomes are shown in Table 1.

The lack of agreement between the treatments occurred at three levels: 1, exact boundaries at quar-

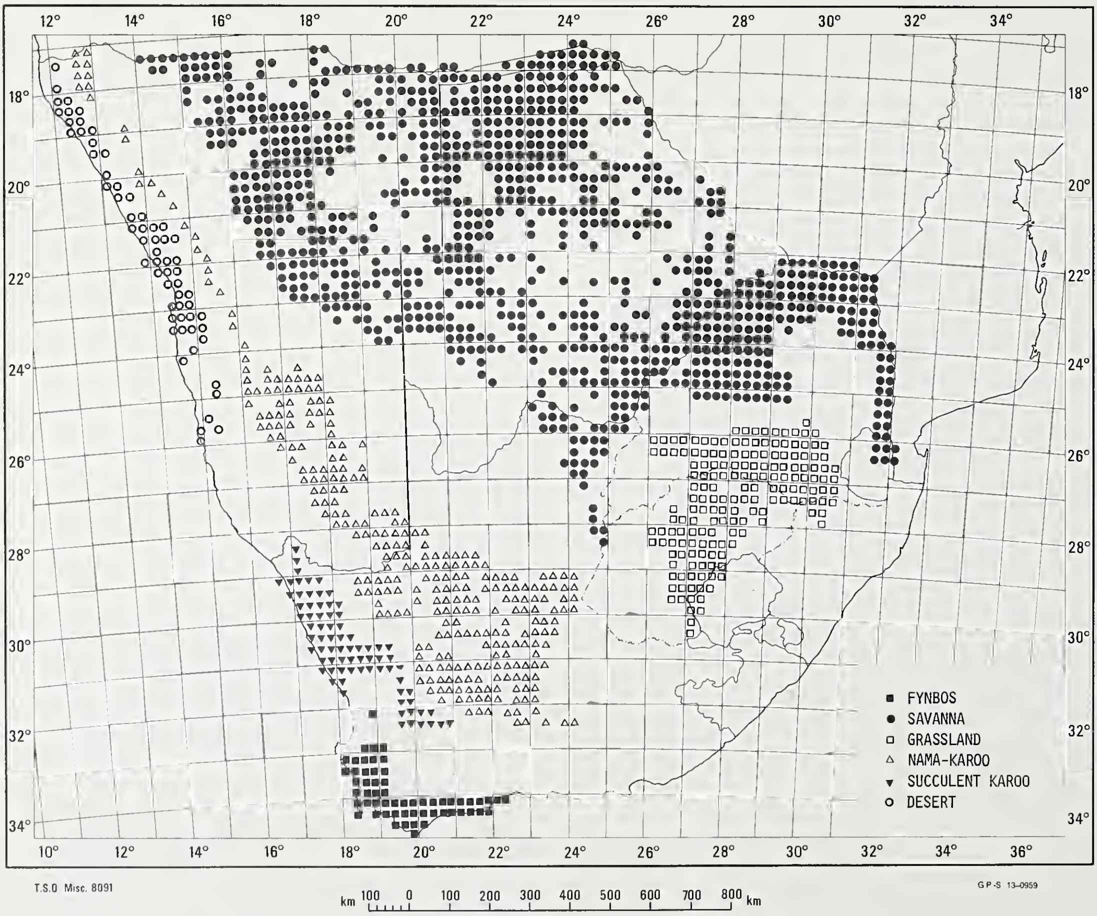

FIGURE 2. — Quarter degree grids searched in PRECIS for each biome.

TABLE 1.—Characteristics of the biomes

Biome	Rainfall amount*	Rainfall season*	Dominant life forms*	Structural characteristics
Fynbos	Mesic (210–3 000 mm)	Winter	Chamaephytes Phanerophytes Cryptophytes	Evergreen sclerophyllous heathland and shrubland†
Savanna	Mesic (above 235 mm)	Summer	Hemicryptophytes Phanerophytes	Wooded C_4 grasslands†
Grassland	Mesic (400–2 000 mm)	Summer	Hemicryptophytes	Grassland, woody plants absent or rare†
Nama-Karoo	Arid (100–520 mm)	Summer (to all year)	Chamaephytes Hemicryptophytes	Dwarf and low open shrublands†
Succulent Karoo	Arid (20–290 mm)	Winter (to all year)	Chamaephytes	Dwarf and low open succulent shrub-lands†
Desert	Arid (13–70 mm)	Summer	Therophytes	Ephemeral, with many annuals

* Rutherford & Westfall (1986)
† Huntley (1974)

ter degree scale; 2, areas of transition between karroid and savanna regions; and 3, areas of complicated vegetation relationships, such as the eastern Transvaal, Natal and the eastern Cape. The two 'karroid' biomes accepted here were recognized at the highest level of classification only by Rutherford & Westfall (1986), on grounds of differences in dominant plant life form and environmental conditions. Their Succulent Karoo Biome roughly coincided with the Western Cape Domain of the Karoo-Namib Region defined by Werger (1978) at a secondary level of classification on phytochorological grounds. The other three vegetation studies treated the entire karroid vegetation as a single entity at the highest level. In this investigation, Succulent Karoo was separated from Nama-Karoo, and a secondary aim of the study was to examine the floristic relationship between them.

Besides the six core biomes adopted for this study, all the treatments recognized the high altitude vegetation of the Drakensberg, and the forests of the southern Cape. However, these small irregularly shaped areas were not accessible to computer search at the scale of quarter degree grid reference, and could therefore not be included.

The PRECIS specimen database records label information for ± 610 000 specimens in the National Herbarium (PRE). The overall operation and implementation of PRECIS have been reported several times (Gibbs Russell & Gonsalves 1984; Gibbs Russell 1985a). More recently, new programming has allowed compilation from the database of checklists of plant species and infraspecific taxa from any combination of quarter degree grids. Several special programmes were written to compare the checklists by providing lists of unique taxa, lists of shared taxa, and a matrix of all taxa with the biomes from which they were recorded.

The total numbers of unique and shared taxa, obtained by employing these programmes, were used to calculate Sorenson's (1948) coefficients of similarity, and percentages of unique taxa and taxa shared between biomes. The ranking of families for each biome, the identification of widespread taxa, and the determination of centres of diversity for 'large' genera with 10 or more species and infraspecific taxa were obtained by manual searches of printout. A biome was considered to be a centre of diversity for a genus if it contained 50% or more of the taxa reported for the genus. In a few cases, slightly less than half (to 45%) was accepted in biomes of low collecting intensity. Life forms follow the definitions of Raunkiaer (1934) as stated by Rutherford & Westfall (1986), but with the inclusion of 'Succulent', and were determined from Dyer (1975, 1976) and herbarium specimens. At all stages of work, doubtful records encountered on PRECIS listings were checked in PRE.

An inherent weakness in the method used is the uneven collecting intensity for the different biomes. Gibbs Russell *et al.* (1984) showed that the collecting intensity represented in PRECIS for the eastern and southern mesic areas is far higher than for the western arid areas. Therefore, the checklists used here undoubtedly differ in completeness, and it must be emphasized that these results are preliminary. Table 2 illustrates the differences in collecting intensity between the biomes by comparing the specimens and the taxa per km^2 as well as the specimens per taxon recorded in PRECIS for each biome. Although Fynbos, and to a lesser degree Grassland, appear to be better collected than the other biomes on a specimens/km^2 or taxa/km^2 basis, Savanna in fact exhibits more 'repeat' collections than either. However, it is apparent that mesic Fynbos, Savanna and Grassland are better collected than arid Nama-Karoo, Succulent Karoo and Desert.

PRECIS is known to have errors in about 7% of specimen identifications and quarter degree grid references. Until these errors can be corrected, an ongoing process in system management, results must be used with discretion. In this study, identifications directly from PRECIS are used only at the level of family and genus, while at the level of species and infraspecific taxa, only total numbers, and not identifications, are used unless the records were checked

TABLE 2.—Collecting intensity reported from PRECIS for each biome. Area was determined from the number of quarter degree grids searched (and 'average' quarter degree covers 666 km²)

	No. specimens	No. taxa	Area (km²)	Specimens/km²	Taxa/km²	Specimens/taxon
Fynbos	52650	7316	36628	1,36	0,19	7,2
Savanna	50460	5788	632034	0,08	0,01	8,7
Grassland	27685	3788	111888	0,25	0,03	7,3
Nama-Karoo	7685	2147	198468	0,04	0,01	3,6
Succulent Karoo	6484	2125	50616	0,13	0,04	3,1
Desert	1334	497	41292	0,03	0,01	2,7

in PRE. For the same reason, distribution is given only at biome level, and not to individual quarter degree grids.

Despite the limitations imposed by differences in collecting intensity and by the accuracy of individual PRECIS records, at the present time PRECIS is the most reliable and complete source of information about the distribution of taxa throughout the southern African flora. Publication of these preliminary results is therefore considered worthwhile.

Throughout the study, the number of species and infraspecific taxa, rather than species alone, were used in comparisons because of taxonomic uncertainty about the correct level of treatment for many of these entities, as explained in detail in Gibbs Russell (1985b). For the sake of brevity, the term 'taxa' in this context is used in place of the longer phrase 'species and infraspecific taxa'.

RESULTS AND DISCUSSION

Area, taxa and specimens

The area, taxa and specimens covered in this study are summarized in Table 3. The five recent vegetation treatments used to determine the biomes for this study agreed on about 40% of the total area of southern Africa at a scale available for computer search. About 60% of all southern African taxa represented in PRECIS were reported from the area designated. Certain taxa were not included in the study for the following reasons: 1, they are known only outside the areas of the core biomes; 2, they are not represented in PRECIS; or 3, they are represented in PRECIS, but the distribution is not recorded as a quarter degree grid. Only about 25% of the specimens in PRECIS are reported in the study. This low figure results from the uneven collecting intensity in the National Herbarium mentioned above.

TABLE 3.—Total size of sample reported for all biomes

Number of specimens	146 298
Out of 610 000 in PRECIS	24%
Out of ±2 000 000 in southern African herbaria	7%
Number of taxa	14 391
Out of 24 000 in southern Africa	60%
Area covered (1 611 quarter degree grids @666 km² per quarter degree)	1 072 926 km²
Out of 2 573 000 km² for southern Africa	42%

Comparison of biomes by numbers of species and infraspecific taxa

Widely differing numbers of taxa have been recorded for the six biomes, and the differences in taxon numbers are not related to the area sampled (Table 2). Fynbos has the most taxa although it is the smallest in area. Savanna, which covers by far the largest area, has about 1 500 fewer taxa than Fynbos. Similarly, Grassland has about 1 700 more taxa than Nama-Karoo, although Nama-Karoo covers about twice the area of Grassland. Nama-Karoo and Succulent Karoo have similar numbers of taxa, but Nama-Karoo covers about four times the area of Succulent Karoo. The number of taxa recorded for Desert is extremely low even though its area is slightly larger than that of Fynbos.

The checklists for each biome were compared both by Sorenson's (1948) coefficient of similarity, and by percentage comparisons within each biome. Sorenson's coefficients give comparable values for checklists of different length. Low Sorenson's coefficients signify low similarity between lists of taxa, while higher values show a greater similarity. The percentage comparisons show the proportion of taxa within each biome that are unique and that are shared with other biomes.

Sorenson's coefficients of similarity

The Sorenson's coefficients of similarity between the six major biomes are shown in Figure 3. The values for the coefficients are generally low (30 or less), indicating that each biome has its own flora which is quite distinct from that of the others. The exception is the coefficient between Savanna and Grassland, which is considerably higher than any other.

For Savanna, the highest Sorenson's coefficients occur with Grassland and with Nama-Karoo, and the values are low (less than 20) for the other biomes. Grassland, which has the strongest similarity to Savanna, has very low Sorenson's coefficients with Desert and with Succulent Karoo, and somewhat higher values with Fynbos and Nama-Karoo. Desert has very low values with all biomes except Nama-Karoo. Fynbos has low Sorenson's coefficients with all biomes except Succulent Karoo. Succulent Karoo and Nama-Karoo show opposite relationships. Excluding the Sorenson's coefficient between the two 'karroid' biomes, Succulent Karoo has its highest value with Fynbos, and very low values with Desert,

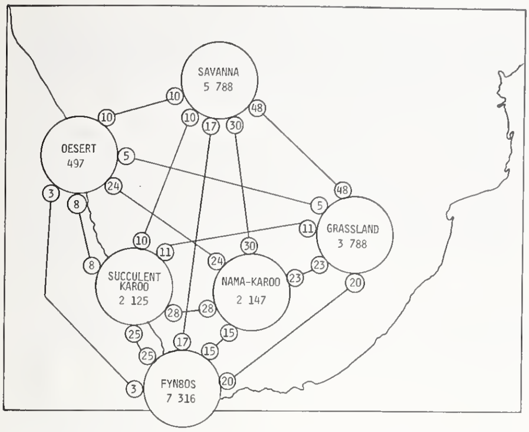

FIGURE 3. — Number of taxa and Sorenson's coefficients of similarity for the biomes. The number in each large circle is the number of species and infraspecific taxa reported for the biome. The number in each small circle is the Sorenson's coefficient of similarity between pairs of biomes.

Savanna and Grassland, whereas Nama-Karoo has its highest value with Savanna, high values with Desert and Grassland, and a low value with Fynbos.

Percentages of unique and shared taxa

The percentages of taxa unique to each biome and shared between biomes are shown in Figure 4. The biomes vary greatly in percentages of unique taxa. Fynbos has the highest percentage (which is consistent with a value of 68% given by Bond & Goldblatt (1984)), and Savanna is also well above the others. Grassland and Succulent Karoo are similar, and Desert and Nama-Karoo have similar and very low percentages of unique taxa.

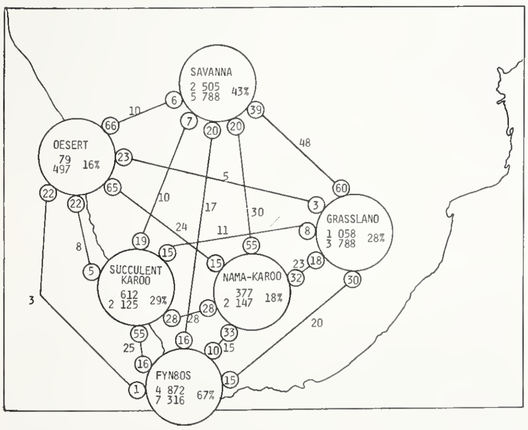

FIGURE 4. — Number and percentage of species and infraspecific taxa unique to and shared between biomes. In each large circle, the upper number is the number of unique taxa, the lower number is the total number of taxa for the biome, and the percentage is the percentage of taxa unique for the biome. The number in each small circle is the percentage of taxa shared between pairs of biomes, and the number on the line connecting a pair is the Sorenson's coefficient of similarity.

The percentage of taxa shared between the biomes amplifies the relationships shown by the Sorenson's coefficients. The few apparent contradictions result from comparing taxon lists of very different length: where one list is long and the other short, the percentage of shared taxa differs markedly from the Sorenson's values.

The close floristic relationships between Savanna and Grassland and Savanna and Nama-Karoo shown by the Sorenson's coefficients are borne out by the high percentage of Grassland and Nama-Karoo taxa that is shared with Savanna. Savanna itself shares most taxa with Grassland, shares the same percentage of its taxa with Nama-Karoo as with Fynbos, and shares a very low percentage of its taxa with Succulent Karoo and Desert. Grassland shares a very high percentage of its taxa with Savanna, and is similar to Savanna in that its lowest percentage of shared taxa is with Succulent Karoo and Desert, but Grassland shares a considerably higher percentage of taxa with Fynbos than with Nama-Karoo. Desert, which because of its small flora shows very low Sorenson's values with all biomes except Nama-Karoo, shares about the same very high percentage of its taxa with Savanna as with Nama-Karoo. Desert has a very low percentage of unique taxa, and shares more than 20% of its taxa with Grassland, with Succulent Karoo and with Fynbos. In contrast, Fynbos, which has a high percentage of unique taxa, does not share more than 20% of its taxa with any other biome. The close relationships of Succulent Karoo to Fynbos and of Nama-Karoo to Savanna, already indicated by Sorenson's coefficients, are borne out by the high percentage of Succulent Karoo taxa shared with Fynbos, and the high percentage of Nama-Karoo taxa shared with Savanna. Both of the 'karroid' biomes share the lowest percentage of taxa with Desert and an intermediate percentage with Grassland.

Comparison of biomes by important families and large genera

Differential occurrence of important families

Forty-six families comprise 1% or more of the taxa in at least one biome. In each biome there are between 22 and 28 families that comprise 1% or more of the taxa, and that together account for between 55 and 60% of the total number of taxa. Each of these families can be used to distinguish and/or link the biomes (Table 4).

In order to compare the biomes in this way, these important families are ranked for every biome by number of taxa from largest (rank of 1) to smallest (rank of 22 to 28). Ranking is necessary for comparison at family level because the biomes differ so greatly in number of taxa. A family well represented in a species-poor biome may in fact have fewer taxa in that biome than the same family has in a biome with a rich flora, even though the family is a negligible component of the more species-rich biome (Gibbs Russell 1975, 1985b). The families are ranked in three groups in the discussion: the largest families (1–3 in bold type in Table 4); the next rank (4–10 in italics in Table 4); and the lowest rank (from

11 onwards in roman type in Table 4). The biomes are characterized by the presence, absence or difference in rank of certain large families, and the occurrence of some families can be linked to simple environmental parameters characteristic of certain combinations of biomes.

The seven plant families that comprise 1% or more of the taxa in all of the biomes are shown in Table 4a. Three families, Asteraceae, Poaceae and Fabaceae are the three largest in all biomes (with the exception of Poaceae in Succulent Karoo and Fynbos), and either Asteraceae or Poaceae is the largest family in all biomes. Asteraceae and not Poaceae is the largest family in Grassland.

The six biomes are briefly discussed in turn below:

Fynbos (Table 4b) is distinguished by eight families that are important in no other biome. Of these, Ericaceae is one of the three largest families, and

TABLE 4.—Families represented by more than 1% of the total number of taxa in any one of the biomes. Sv, Savanna; G, Grassland; D, Desert; N-K, Nama-Karoo; SK, Succulent Karoo; F, Fynbos. The number in the matrix is the rank according to number of taxa in the family in a given biome, with '1' signifying the largest family in the biome

	Sv	G	D	N-K	SK	F
4a. Families comprising more than 1% of the total number of taxa in all biomes						
Asteraceae	3	1	2	1	1	1
Poaceae	1	2	1	2	*4*	*5*
Fabaceae	2	3	3	3	3	2
Liliaceae	*5*	*4*	*10*	*4*	*5*	*7*
Scrophulariaceae	*10*	*6*	*7*	*5*	*6*	12
Cyperaceae	*6*	*5*	12	13	20	*9*
Euphorbiaceae	*8*	12	11	*9*	19	24
4b. Families that distinguish Fynbos						
Presence of:						
Ericaceae						3
Restionaceae						*8*
Rutaceae						*10*
Polygalaceae						14
Thymelaeaceae						15
Rhamnaceae						20
Rosaceae						22
Lobeliaceae						28
High rank of:						
Proteaceae					17	*6*
Absence or low rank of:						
Asclepiadaceae	*9*	*7*	13	*10*	15	
Scrophulariaceae	*10*	*6*	*7*	*5*	*6*	12
4c. Families that distinguish Savanna						
Presence of:						
Verbenaceae	21					
High rank of:						
Rubiaceae	*4*	11				
Absence of:						
Mesembryanthemaceae		13	*8*	*8*	*7*	13
4d. Families that distinguish Grassland						
High rank of:						
Orchidaceae	14	*8*				11
Lamiaceae	11	*9*		20		
Absence of:						
Sterculiaceae	16		14	11	14	27
Aizoaceae	15		*4*	7	*8*	23
4e. Families that distinguish Nama-Karoo						
No families form more than 1% of flora only in Nama-Karoo.						
No families have high rank only in Nama-Karoo.						
No families are absent only from Nama-Karoo.						
4f. Families that distinguish Succulent Karoo						
High rank of:						
Iridaceae	17	*10*		14	2	*4*
Crassulaceae		14		12	*9*	19
Geraniaceae			23	16	*10*	16
4g. Families that distinguish Desert						
Presence of:						
Pedaliaceae			17			
Burseraceae			20			
High rank of:						
Chenopodiaceae			*5*	15	18	
Capparaceae			*9*	24		
Absence of:						
Iridaceae	17	*10*		14	2	*4*
4h. Families that link summer rainfall biomes						
Presence of:						
Acanthaceae	*7*	19	*6*	*6*		
Malvaceae	12	17	21	19		
Lamiaceae	11	*9*		20		
Cucurbitaceae	19		22	22		
Amaranthaceae	18		16			
Rubiaceae	*4*	11				
Convolvulaceae	13	15				
Anacardiaceae	20	20				
Solanaceae		22	19	21		
Capparaceae			*9*	24		
Boraginaceae			18	23		
4i. Families that link winter rainfall biomes						
Presence of:						
Proteaceae					17	*6*
Oxalidaceae					11	21
Campanulaceae					21	18
Low rank of:						
Poaceae	1	2	1	2	*4*	*5*
Euphorbiaceae	*8*	12	11	*9*	19	24
4j. Families that link arid biomes						
Presence of:						
Chenopodiaceae			*5*	15	18	
Zygophyllaceae			15	17	22	
High rank of:						
Aizoaceae	15		*4*	7	*8*	23
Mesembryanthemaceae		13	*8*	*8*	*7*	13
4k. Families that link Grassland and/or Nama-Karoo to Succulent Karoo and/or Fynbos						
Presence of:						
Crassulaceae		14		12	*9*	19
Brassicaceae		23		18	13	25
Selaginaceae		21		25	12	26
Geraniaceae			23	16	*10*	16
Amaryllidaceae		16			16	
Apiaceae		18				17
High rank of:						
Iridaceae	17	*10*		14	2	*4*
Orchidaceae	14	*8*				11

Restionaceae, Rutaceae and Proteaceae among the ten largest families in Fynbos only. In contrast, Asclepiadaceae is not important, and only in Fynbos is Scrophulariaceae not one of the ten largest families. *Savanna* (Table 4c) is distinguished by one important family, Verbenaceae, one family, Rubiaceae, that ranks among the ten largest in no other biome, and one family, Mesembryanthemaceae, that does not occur among the important families. *Grassland* (Table 4d) is distinguished by the high rank of Orchidaceae and Lamiaceae, which are among the ten largest families only in this biome, and only here are Sterculiaceae and Aizoaceae absent from the important families. *Nama-Karoo* (Table 4e) is the only biome which is not distinguished from the others by differential occurrence of families. *Succulent Karoo* (Table 4f) is distinguished by the high rank of Iridaceae, which is one of the three largest families, and Crassulaceae and Geraniaceae, which are among the ten largest families only in this biome. *Desert* (Table 4g) is distinguished by the occurrence of Pedaliaceae and Burseraceae as important families, by the occurrence of Chenopodiaceae and Capparaceae among the ten largest families, and by the absence of Iridaceae as an important family.

A number of families indicate floristic relationships between biomes with different rainfall seasonality and amount. The four summer rainfall biomes (Table 4h) are variously linked by 11 families that do not occur as an important component of the winter rainfall biomes. Winter rainfall biomes (Table 4i) are linked by the occurrence of three families, Proteaceae, Oxalidaceae and Campanulaceae, that are not important in summer rainfall areas, and one family, Poaceae, that ranks first or second in summer rainfall biomes, but has a lower rank in the winter rainfall areas.

In contrast to the above groupings based on rainfall seasonality, other families link biomes with similar amounts of rainfall. The arid biomes are linked by four families (Table 4j). Chenopodiaceae and Zygophyllaceae are important, and Aizoaceae and Mesembryanthemaceae are among the ten largest families only in the arid biomes. Finally, a group of six families, all with low ranking, weakly links the summer rainfall biomes Grassland and Nama-Karoo to the winter rainfall biomes (Table 4k). Savanna is not linked to the winter rainfall biomes at family level.

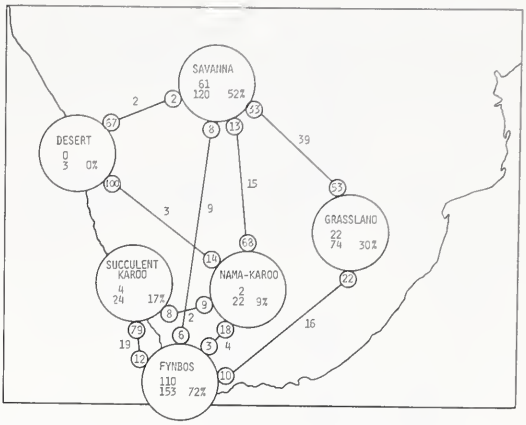

FIGURE 5. — Number and percentage of large genera (10 or more taxa) with centres of diversity in each biome and shared between biomes. In each large circle, the upper number is the number of large genera with a centre of diversity only in that biome, the lower number is the total number of large genera with a centre of diversity in that biome, and the percentage is the percentage of large genera with a centre of diversity only in that biome. The number in each small circle is the percentage of genera shared between pairs of biomes, and the number on the line between a pair is the number of genera with shared centres of diversity. Absence of linkage lines indicates no large genera in common.

Centres of diversity of large genera

The large genera (with 10 or more taxa) with centres of diversity in one, two or three biomes are listed in Appendices 1–3. The large genera with no apparent centre of diversity are listed in Appendix 4. Figure 5 summarizes this information by showing the numbers and percentages of large genera with centres of diversity within and shared between the biomes.

Only in the case of Fynbos and Savanna are more than half the large genera centred in a single biome, whereas each of the other four biomes shares more than half its large genera with another biome. The highest number of large genera have their centre of diversity in Fynbos, and 72% of these genera are centred only in Fynbos. Fynbos is a shared centre of diversity for similar numbers of genera with Succulent Karoo and with Grassland, and for low numbers with Savanna and with Nama-Karoo. No genera have centres of diversity in both Fynbos and Desert. In Savanna, as in Fynbos, over half the large genera have centres of diversity in no other biome, and Savanna also shares genera with centres of diversity in four other biomes. No genera have centres of diversity in both Savanna and Succulent Karoo. For Grassland, over half the large genera share their centres of diversity with Savanna, and nearly a quarter share their centres of diversity with Fynbos. Grassland shares large genera only with Savanna and Fynbos, and no genera have centres of diversity in both Grassland and Nama-Karoo, Grassland and Succulent Karoo or Grassland and Desert. A very low percentage of large genera have their centre of diversity in Nama-Karoo alone. Over two-thirds of large genera in Nama-Karoo share their centre of diversity with Savanna, and Nama-Karoo shares genera with centres of diversity in all biomes except Grassland. In Succulent Karoo, a very high percentage of large genera shares a centre of diversity with Fynbos, and a low percentage shares a centre of diversity with Nama-Karoo. Succulent Karoo shares large genera only with Fynbos and Nama-Karoo, and no genera have centres of diversity in both Succulent Karoo and Savanna, Succulent Karoo and Grassland or Succulent Karoo and Desert. Only two genera have their diversity centred in both of the 'karroid' biomes, and this is the lowest percentage of shared large genera for either Nama-Karoo or Succulent Karoo. Only three large genera have a centre of diversity in Desert, and all three are shared with

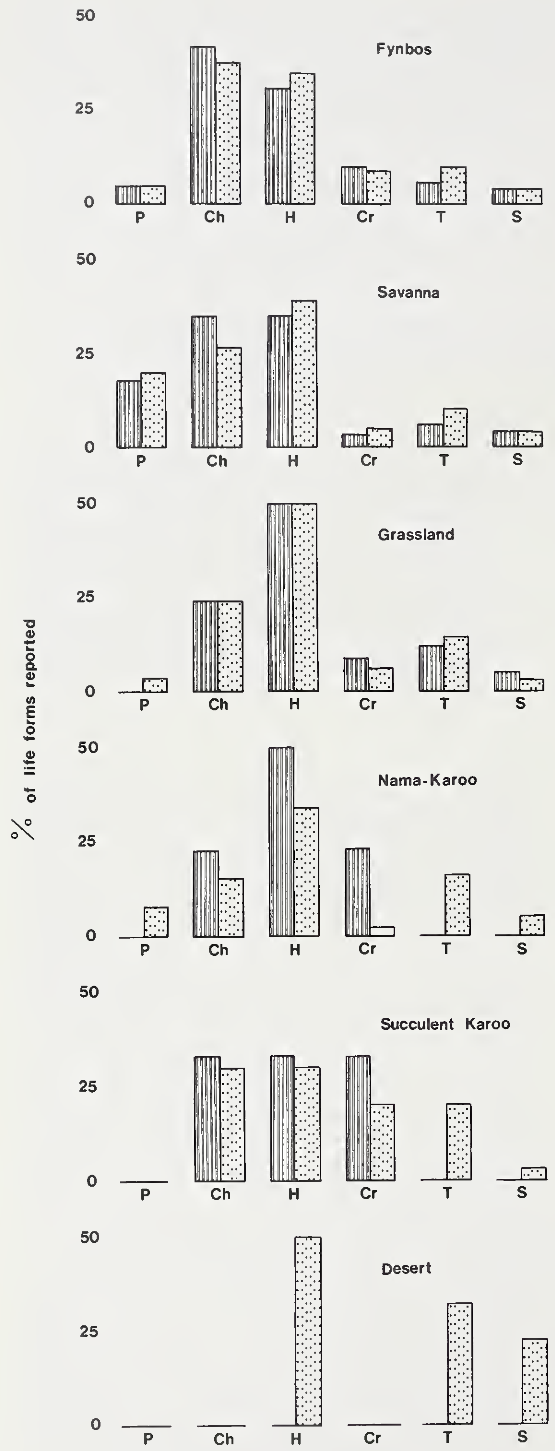

FIGURE 6. — Life form spectra of large genera (10 or more taxa) for each biome. Life forms of genera with centres of diversity only in a particular biome are shown by stripes, and life forms in all genera with centres of diversity in a particular as well as in other biomes are shown by stippling. Life forms are indicated by the following symbols: P = phanerophytes; Ch = chamaephytes; H = hemicryptophytes; Cr = cryptophytes; T = therophytes; S = succulents.

Savanna or with Nama-Karoo. No genera have centres of diversity in both Desert and Grassland, Desert and Succulent Karoo, or Desert and Fynbos.

Life forms and centres of diversity of large genera

Figure 6 shows life form spectra for large genera with centres of diversity either only in one or in more than one biome. The basis for plant classification is that floral characters are conservative at family and genus level, whereas vegetative characters can be variable between members of a higher category. Raunkiaer's life forms indicate broad basic differences in vegetative states, depending on the position of the perennating bud, and indicate differences in utilization of resources. The fact that a genus has many species and infraspecific taxa in a certain biome suggests that the adaptations displayed by the taxa are compatible with the environment of that biome. Thus the differences in characteristics of the genera, as illustrated by life forms, can show convergent adaptations in a number of separate evolutionary lines to the conditions in the biome. However, a centre of diversity for a genus in a particular biome does not imply that speciation occurred either in that biome, or under current environmental conditions.

The biomes are characterized by differences in the life forms reported in the large genera. In Fynbos, chamaephytes are the most commonly reported life form in the large genera. In Savanna, phanerophytes are reported more frequently than in any other biome. For Grassland, nearly half the life forms reported are hemicryptophytes. Grassland differs from Savanna by having fewer phanerophytes and chamaephytes (the woody component), and from Nama-Karoo by having fewer cryptophytes. Nama-Karoo is similar to Grassland, but with more cryptophytes reported among the few genera with their centre of diversity in Nama-Karoo only. Succulent Karoo is remarkable because it has similar values for chamaephytes, hemicryptophytes and cryptophytes. The comparative value for cryptophytes is far higher than for any other biome, and phanerophytes are not reported at all. The life form spectrum for Desert may be misleading because it is based on three genera only, and therefore it is not considered further.

The differences in occurrence of each of the life forms in the biomes can also be examined. Phanerophytes appear only in genera with a centre of diversity in Fynbos or Savanna. Chamaephytes and hemicryptophytes show a basic difference between the summer and the winter rainfall biomes. Chamaephytes are reported most often in winter rainfall Fynbos and Succulent Karoo. Hemicryptophytes are the most abundant life form in the summer rainfall Savanna, Grassland, Nama-Karoo and Desert. Cryptophytes occur in low numbers in all the biomes, but are reported often only in genera with their centre of diversity in Succulent Karoo, and to a lesser extent, Nama-Karoo. Therophytes are reported in all biomes, but are less frequently reported in genera of which the centre of diversity is confined to a single biome, and are more frequently reported in genera with centres in more than one

biome. Succulents are reported in all biomes, but the mesic biomes Fynbos, Savanna and Grassland, have succulents reported in genera with centres in each one, while the more arid Succulent Karoo and Nama-Karoo have succulents reported only in genera with centres of diversity in more than one biome.

Floristic characteristics and relationships of the biomes

Fynbos

Fynbos has the largest number of taxa, the highest percent of unique taxa, the largest number of important families that do not occur in any other biome, and the greatest number of centres of diversity for large genera. At species level, the Sorenson's coefficient of similarity and the percentage of shared taxa show that Fynbos is most closely related to Succulent Karoo, the other winter rainfall biome. At the generic level, Fynbos shares more centres of diversity for large genera with Succulent Karoo than with any other biome. At the family level, Fynbos is linked only to Succulent Karoo by four important families. The less-marked relationship between Fynbos and Grassland will be discussed under Grassland below.

Savanna

Savanna is second to Fynbos in number of taxa, percentage of unique taxa, and in number of centres of diversity for large genera. However, Savanna is distinguished at family level by only three families, while it is linked to the other summer rainfall biomes by eight families. The closest relationship of Savanna is to Grassland, as shown by the very high Sorenson's coefficient of similarity and the percentage of shared taxa, the number of large genera with centres of diversity in both Savanna and Grassland, and the six families that link them, three of which are important only in Savanna and Grassland. A weaker relationship between Savanna and Nama-Karoo is shown by a high Sorenson's coefficient and the percentage of shared taxa, a considerable number of large genera with centres of diversity in both Savanna and Nama-Karoo, and by four families that link them.

Grassland

A moderately large number of taxa is reported for Grassland, which is distinguished by four families. Its relationship with Savanna is the closest demonstrated in this study, as discussed above. Grassland shows similar moderate Sorenson's coefficients with both Nama-Karoo and Fynbos, but other comparisons show that Grassland is in fact more closely related to Fynbos than to Nama-Karoo. The percentage of Grassland taxa shared with Fynbos is far higher than the percentage shared with Nama-Karoo, and a number of large genera, nearly all hemicryptophytes, have centres of diversity in both Grassland and Fynbos, while no large genera have centres of diversity in both Grassland and Nama-Karoo. At family level, Grassland is linked to Nama-Karoo only by families that also link it to Savanna (Table 4h) or to Fynbos (Table 4k), while it is linked independently to Fynbos by two families (Table 4k).

Nama-Karoo

Nama-Karoo is not well defined floristically in this study. At species level, its number of taxa is low, particularly with respect to its large area, and the percentage of unique taxa is very low, hardly higher than that of Desert. Nama-Karoo is the only biome for which all Sorenson's coefficients except one (to Fynbos) are greater than 20. Over half of Nama-Karoo taxa are shared with Savanna, about a third are shared with Grassland and another third with Fynbos. At generic level, few large genera have a centre of diversity in Nama-Karoo, and of these, more have a shared centre of diversity with Savanna, with Fynbos or with Desert than are centred in Nama-Karoo alone. At family level, Nama-Karoo is the only biome that cannot be defined by differential occurrence of important families. It is linked to all the other summer rainfall biomes, and also to the winter rainfall Succulent Karoo through the arid biomes.

Succulent Karoo

The number of taxa reported for Succulent Karoo is similar to that of Nama-Karoo, but the area covered is about a quarter as large, and Succulent Karoo has more unique taxa. It is distinguished from other biomes by three important families. Succulent Karoo is shown by Sorenson's coefficients, by percentage of shared taxa and by centres of diversity of large genera to be related floristically both to Fynbos and Nama-Karoo. The much higher values in every case show that the relationship is strongest to Fynbos (see *Fynbos* above). Over half the Succulent Karoo taxa and over three quarters of the large genera are shared with Fynbos. At family level, the strong links of Succulent Karoo to Fynbos are shown by four families that are important only in these two biomes, whereas at family level Succulent Karoo is linked to Nama-Karoo only through the group of families that links the three arid biomes.

Desert

A very small number of taxa are reported for Desert, and the percentage of unique taxa is lower than for any other biome. There are no large genera with a centre of diversity in Desert alone. However, Desert is distinguished by four important families. Relationships of the Desert flora are shown by Sorenson's coefficients and by the percentage of shared taxa, to be highest with Savanna and with Nama-Karoo, and it is only with these two biomes that Desert shares centres of diversity for large genera. In addition, Desert is linked to Nama-Karoo by ten families, two of which are important only in Desert and Nama-Karoo, and it is linked to Savanna by four families, one of which is important only in Desert and Savanna. Desert is also linked to the arid but winter rainfall Succulent Karoo by four families.

Relationships

The distribution of species, genera and families and the life form spectra shows that the biomes fall floristically into two groups, which correspond to the summer rainfall region (Savanna, Grassland, Nama-Karoo, Desert) and the winter rainfall region (Fynbos, Succulent Karoo). The present analysis of 14 000 taxa therefore supports and extends the 'winter rainfall biome' concept first put forward on the basis of a few genera by Bayer (1984). A detailed study of grass subfamily distributions also shows a similar basic division, with Chloridoideae and Panicoideae most abundant in summer rainfall areas and Arundinoideae most abundant in winter rainfall areas (Gibbs Russell 1986).

Nama-Karoo and Succulent Karoo, which have previously been placed together at highest level in all vegetation studies except that of Rutherford & Westfall (1986), are not closely related floristically. Nama-Karoo is more closely related to Savanna than to Succulent Karoo, and Succulent Karoo is more closely related to Fynbos than to Nama-Karoo.

Within the summer rainfall group, at species level, the strongest relationship is between Savanna and Grassland, with a weaker relationship between Savanna and Nama-Karoo. The same relationships are shown at generic level, and the distinctness of Nama-Karoo from Grassland and of Desert from Succulent Karoo is emphasized. At family level, particular families link and demarcate the summer rainfall biomes and the winter rainfall biomes, but another group of families complicates this simple difference by linking the arid biomes of both summer and winter rainfall regimes.

Secondary links connect the two major groups through Nama-Karoo, which lies between the other biomes geographically. Nama-Karoo is ill-defined as an entity, and is strongly linked at species, genus and family level to Savanna and Desert; it is more weakly linked at species and family level to Succulent Karoo and at genus level to Fynbos. Grassland, which is very strongly allied to Savanna, shows a secondary link to Fynbos, independent of Nama-Karoo, at species, genus and family level.

CONCLUSIONS

At the highest level of floristic comparison the winter rainfall biomes and the summer rainfall biomes form two separate groups. Within these groups, each biome is floristically distinct at the level of species and infraspecific taxa, whether measured by Sorenson's coefficient of similarity or by percentage of shared taxa, and each biome (except Desert) is rich in taxa. Each is a centre of diversity for certain large genera, and the life form spectrum for these genera is different for each biome. Each (except Nama-Karoo) is distinguished by differences in the occurrence of important plant families.

The floristic distinctness of the biomes, coupled with high taxon numbers, implies that each should be studied and managed as a separate entity. Because of the high numbers of species and infraspecific taxa, it is unlikely that conservation of limited areas in nature reserves will protect a large proportion of the taxa in any one biome.

This study is hampered by the dearth of specimen records from arid areas, and for this reason it may be criticized for being too preliminary. However, the trends indicated should serve as stimulus to more precise analyses. Unfortunately precision can only be achieved when primary data are available to compile more complete and accurate checklists. This should be done through bringing together records from many herbaria and from literature, and most important, through rationally planned specimen collecting designed to cover all biomes adequately.

The conclusions are based on plant distributions as they are now known, that result from interactions over a long geological, climatological and evolutionary history. It is not apparent to what extent these distributions have been influenced by present or past environments. However, listing and comparing the taxa in each biome is the first step in unravelling the events that have led to the formation of its characteristic flora. PRECIS has given us a preliminary look that will allow the generation of hypotheses for more rigorous testing using stronger data sets and more refined techniques.

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APPENDIX 1.—Large genera (10 taxa or more) with centre of diversity in one biome. * = genera reported only from a single biome. Life forms are abbreviated: P, phanerophyte; Ch, chamaephyte; H, hemicryptophyte; Cr, cryptophyte; T, therophyte; S, succulent

a. Large genera with centre of diversity reported for Fynbos only

Family and genus	Total no. of taxa reported	% of the reported taxa in Fynbos	Life form
Pottiaceae			
Tortula	12	83	H
Poaceae			
Merxmuellera	12	66	H
Pentaschistis	47	82	H
Cyperaceae			
Ficinia	54	98	H
Isolepis	19	78	H
Tetraria	35	97	H
Restionaceae			
Restio	109	94	H
Chondropetalum*	19	100	H
Elegia*	36	100	H
Leptocarpus	22	100	H
Thamnochortus	29	100	H
Hypodiscus*	12	100	H
Juncaceae			
Juncus	19	89	H
Liliaceae *s.l.*			
Wurmbea	12	91	Cr
Trachyandra	44	54	Cr
Haworthia	22	63	H, S
Ornithogalum	44	59	Cr
Lachenalia	46	82	Cr
Hypoxidaceae			
Spiloxene	15	86	Cr
Iridaceae			
Romulea	51	62	Cr
Galaxia	11	81	Cr
Moraea	62	64	Cr
Homeria	22	63	Cr
Bobartia*	12	100	H
Aristea	29	82	H
Geissorhiza	58	98	Cr
Ixia	41	97	Cr
Tritonia	17	58	Cr
Gladiolus	103	72	Cr
Tritoniopsis*	13	100	Cr
Watsonia	16	81	Cr
Orchidaceae			
Holothrix	13	69	H
Satyrium	32	75	H
Disa	59	79	H
Monadenia	12	91	H
Corycium	13	69	H
Proteaceae			
Paranomus	13	100	P, Ch
Serruria	57	100	Ch
Spatalla	15	100	Ch
Protea	62	87	P, Ch
Leucospermum	39	97	P, Ch
Leucadendron	64	93	P, Ch
Santalaceae			
Thesium	95	54	Ch, H
Mesembryanthemaceae			
Drosanthemum	17	64	Ch, S
Erepsia*	12	100	Ch, S
Lampranthus	43	86	Ch, S
Caryophyllaceae			
Silene	12	91	H
Droseraceae			
Drosera	16	75	H
Crassulaceae			
Crassula	137	54	Ch, H, S
Adromischus	15	53	Ch, S
Bruniaceae			
Raspalia	10	100	Ch
Berzelia	10	100	Ch
Rosaceae			
Cliffortia	77	96	P, Ch
Fabaceae			
Cyclopia*	17	100	Ch
Podalyria	12	100	Ch
Priestleya	16	100	Ch
Rafnia	18	100	Ch, H
Lebeckia	24	70	Ch, H
Aspalathus	220	97	P, Ch
Geraniaceae			
Pelargonium	121	89	Ch, H, Cr, T
Oxalidaceae			
Oxalis	135	68	Ch, H, Cr, T
Rutaceae			
Agathosma	68	100	Ch
Adenandra*	23	100	Ch
Acmadenia*	11	100	Ch
Diosma	20	100	Ch
Euchaetis	20	100	Ch
Polygalaceae			
Polygala	50	58	Ch, H
Muraltia	91	95	Ch
Euphorbiaceae			
Clutia	24	75	Ch
Rhamnaceae			
Phylica	93	97	P, Ch
Malvaceae			
Anisodontea	12	83	Ch, H
Sterculiaceae			
Hermannia	145	46	Ch, H
Thymelaeaceae			
Gnidia	64	71	Ch
Struthiola	25	100	Ch
Lachnaea	20	100	Ch
Passerina	14	92	Ch
Apiaceae			
Centella	34	100	H
Peucedanum	15	53	Ch, H
Ericaceae			
Erica	460	96	P, Ch
Blaeria*	12	100	Ch
Grisebachia	10	70	Ch
Simocheilus*	17	100	Ch
Syndesmanthus*	11	100	Ch
Schyphogyne*	12	100	Ch
Plumbaginaceae			
Limonium	16	87	Ch, H
Gentianaceae			
Chironia	15	66	Ch, H
Boraginaceae			
Lobostemon	21	100	Ch

Scrophulariaceae			
Polycarena	23	60	H, T
Harveya	15	73	H
Selaginaceae			
Selago	61	63	Ch
Rubiaceae			
Anthospermum	17	70	Ch
Campanulaceae			
Roella*	23	100	Ch, H
Prismatocarpus	21	90	Ch, H
Lightfootia	35	77	Ch, H
Lobeliaceae			
Cyphia	27	55	H, Cr
Lobelia	51	70	Ch, H, T
Monopsis	13	92	H, T
Asteraceae			
Mairea	12	100	Ch, H
Felicia	62	66	Ch, H
Helipterum	11	100	H, T
Stoebe	21	100	Ch
Metalasia	23	91	Ch
Relhania	18	77	Ch, T
Athanasia	25	88	Ch
Cotula	22	59	H, T
Senecio	182	48	Ch, H, S
Euryops	46	54	Ch, H, T
Osteospermum	56	66	Ch, H
Ursinia	37	78	Ch, H, T
Cullumia	13	92	Ch

b. Large genera with centre of diversity reported for Savanna only

Family and genus	Total no. of taxa reported	% of the reported taxa in Savanna	Life form
Ricciaceae			
Riccia	20	55	H
Marsileaceae			
Marsilea	11	90	H
Adiantaceae			
Cheilanthes	26	57	H
Zamiaceae			
Encephalartos	10	70	P, Ch
Poaceae			
Brachiaria	19	100	H
Panicum	35	97	H
Pennisetum	14	64	H
Sporobolus	38	89	H
Eragrostis	81	88	H
Cyperaceae			
Mariscus	32	90	H
Fuirena	13	76	H
Eleocharis	10	90	H
Liliaceae *s.l.*			
Chlorophytum	11	54	Cr
Urginea	17	47	Cr
Dipcadi	14	92	Cr
Protasparagus	41	63	Ch
Amaryllidaceae			
Crinum	18	94	Cr
Moraceae			
Ficus	18	100	P
Loranthaceae			
Tapinanthus	16	100	Ch
Viscaceae			
Viscum	13	61	Ch
Amaranthaceae			
Amaranthus	12	83	T
Capparaceae			
Maerua	12	83	P, Ch
Fabaceae			
Albizia	10	90	P, Ch
Acacia	63	79	P, Ch
Cassia	22	90	P, Ch, H
Crotalaria	50	90	Ch, H
Indigofera	170	52	Ch, H
Psoralea	38	97	Ch, H
Tephrosia	49	88	Ch, H
Sesbania	17	82	P, Ch, H
Aeschynomene	10	80	Ch, H, T
Rhynchosia	44	73	Ch, H
Vigna	14	100	H
Euphorbiaceae			
Phyllanthus	14	78	P, Ch, H
Croton	10	100	P, Ch, H
Jatropha	15	86	Ch, H
Euphorbia	123	46	P, Ch, H, S
Anacardiaceae			
Ozoroa	13	84	P, Ch
Vitaceae			
Cyphostemma	23	78	Ch, H
Tiliaceae			
Corchorus	12	100	Ch, H
Grewia	24	91	P, Ch
Triumfetta	11	91	Ch, H
Malvaceae			
Abutilon	16	93	P, Ch, H
Pavonia	11	72	Ch, H
Hibiscus	45	93	P, Ch, H, T
Sterculiaceae			
Melhania	10	100	Ch, H
Ochnaceae			
Ochna	10	90	P, Ch
Elatinaceae			
Bergia	10	90	Ch, H
Lythraceae			
Nesaea	16	87	Ch, H, T
Combretaceae			
Combretum	32	96	P, Ch
Ebenaceae			
Diospyros	19	73	P, Ch
Asclepiadaceae			
Ceropegia	21	95	H, S
Huernia	17	82	H, S
Convolvulaceae			
Ipomoea	43	90	Ch, H, T
Verbenaceae			
Clerodendrum	10	100	P, Ch, H
Lamiaceae			
Leonotis	11	91	Ch, H
Lentibulariaceae			
Utricularia	14	92	H
Acanthaceae			
Barleria	47	85	Ch
Blepharis	35	65	Ch, H, T
Justicia	24	87	Ch, H
Rubiaceae			
Kohautia	14	85	Ch, H, T
Oldenlandia	13	100	Ch, H
Canthium	14	92	P, Ch
Asteraceae			
Geigeria	14	92	Ch, H
Dicoma	14	78	Ch, H

c. Large genera with centre of diversity reported for Grassland only

Family and genus	Total no. of taxa reported	% of the reported taxa in Grassland	Life form
Cyperaceae			
Carex	13	69	H
Liliaceae *s.l.*			
Kniphofia	23	73	H
Agapanthus	11	63	H
Tulbaghia	12	75	H
Amaryllidaceae			
Nerine	14	57	Cr
Cyrtanthus	20	55	Cr
Iridaceae			
Dierama	10	100	Cr
Mesembryanthemaceae			
Delosperma	24	79	Ch, H, S
Portulacaceae			
Anacampseros	11	45	Ch, H, S
Brassicaceae			
Lepidium	13	53	Ch, H, T

Fabaceae			
Lotononis	33	45	Ch, H
Pearsonia	10	90	Ch, H
Onagraceae			
Oenothera	12	91	Ch, H, T
Apiaceae			
Alepidea	13	92	H
Asclepiadaceae			
Aspidoglossum	12	83	H
Pachycarpus	13	84	H
Lamiaceae			
Stachys	29	51	Ch, H, T
Salvia	25	60	Ch, H
Scrophulariaceae			
Zaluzianskya	10	45	H, T
Gesneriaceae			
Streptocarpus	10	50	H
Asteraceae			
Helichrysum	147	55	Ch, H
Gerbera	12	50	H

d. Large genera with centre of diversity reported for Succulent Karoo only

Family and genus	Total no. of taxa reported	% of the reported taxa in Succulent Karoo	Life form
Liliaceae *s.l.*			
Androcymbium	21	57	Cr
Iridaceae			
Lapeirousia	13	48	Cr
Aizoaceae			
Galenia	26	61	Ch, H
Crassulaceae			
Tylecodon	13	76	Ch, H, S

e. Large genera with centre of diversity reported for Nama-Karoo only

Family and genus	Total no. of taxa reported	% of the reported taxa in Nama-Karoo	Life form
Mesembryanthemaceae			
Lithops	12	83	H, S
Asteraceae			
Pentzia	25	60	Ch, H

APPENDIX 2.—Large genera (10 taxa or more) with centres of diversity in two biomes. Life forms are abbreviated: P, phanerophyte; Ch, chamaephyte; H, hemicryptophyte; Cr, cryptophyte; T, therophyte; S, succulent

a. Large genera with centre of diversity reported for Savanna and Grassland

Family and genus	Total no. of taxa reported	% of reported taxa in: Savanna	Grassland	Life form
Aspleniaceae				
Asplenium	13	62	62	H
Poaceae				
Andropogon	12	67	83	H
Hyparrhenia	17	100	65	H
Digitaria	29	93	62	H
Setaria	17	88	59	H
Aristida	38	92	55	H, T
Cyperaceae				
Cyperus	63	84	54	H, T
Pycreus	18	89	56	H, T
Kyllinga	10	70	80	H, T
Schoenoplectus	17	76	71	H, T
Bulbostylis	10	90	90	H, T
Scleria*	13	85	46	H
Commelinaceae				
Commelina	19	95	53	H, T
Liliaceae *s.l.*				
Anthericum	17	88	53	Cr
Ledebouria	12	92	83	Cr
Hypoxidaceae				
Hypoxis	20	50	80	Cr
Dioscoreaceae				
Dioscorea	16	88	50	Ch, H, Cr
Orchidaceae				
Habenaria	18	50	61	H, Cr
Eulophia	35	66	51	H
Polygonaceae				
Polygonum	15	66	60	Ch, H
Chenopodiaceae				
Chenopodium	21	76	52	H, T
Fabaceae				
Eriosema	22	68	64	Ch, H
Euphorbiaceae				
Acalypha	16	94	62	P, Ch, H
Chamaesyce	10	90	50	H
Anacardiaceae				
Rhus	61	52	48	P, Ch
Malvaceae				
Sida	13	92	54	Ch, H
Oleaceae				
Jasminum	10	70	50	Ch
Asclepiadaceae				
Asclepias	37	57	81	Ch, H
Brachystelma	20	70	45	H
Convolvulaceae				
Convolvulus	20	60	70	H
Verbenaceae				
Chascanum	13	69	62	Ch, H
Lamiaceae				
Plectranthus	29	76	48	Ch, H, T
Hemizygia	15	67	47	Ch, H
Solanaceae				
Solanum	38	68	53	P, Ch, H
Scrophulariaceae				
Alectra	11	73	55	H, T
Rubiaceae				
Pavetta	14	93	50	P, Ch

b. Large genera with centres of diversity reported for Savanna and Nama-Karoo

Family and genus	Total no. of taxa reported	% of reported taxa in: Savanna	Nama-Karoo	Life form
Aizoaceae				
Limeum	28	75	50	Ch, H, T
Capparaceae				
Cleome	19	89	50	H, T
Boscia	10	70	50	P, Ch
Fabaceae				
Melolobium	15	53	53	Ch
Burseraceae				
Commiphora	27	67	55	P, Ch
Boraginaceae				
Heliotropium	15	80	73	Ch, H
Solanaceae				
Lycium	14	64	57	P, Ch
Scrophulariaceae				
Aptosimum	15	93	67	Ch, H
Selaginaceae				
Walafrida	14	50	57	Ch, H, T
Acanthaceae				
Petalidium	25	52	72	Ch, H
Monechma	22	59	68	Ch
Cucurbitaceae				
Cucumis	15	87	47	H, T

c. Large genera with centres of diversity reported for Savanna and Fynbos

Family and genus	Total no. of taxa reported	% of reported taxa in: Savanna	Fynbos	Life form
Dicranaceae				
Campylopus	13	62	77	H
Crassulaceae				
Cotyledon	11	45	55	Ch, H, S
Celastraceae				
Cassine	12	50	75	P, Ch
Ebenaceae				
Euclea	18	67	61	P, Ch
Asclepiadaceae				
Cynanchum	10	50	50	Ch, H

d. Large genera with centres of diversity reported for Fynbos and Grassland

Family and genus	Total no. of taxa reported	% of reported taxa in: Fynbos	Grassland	Life form
Bryaceae				
Bryum	15	60	73	H
Poaceae				
Agrostis	13	54	54	H
Orchidaceae				
Disperis	17	47	47	H
Polygonaceae				
Rumex	13	77	77	Ch, H
Chenopodiaceae				
Atriplex	10	50	70	Ch, H
Caryophyllaceae				
Dianthus	18	44	50	H, T
Fabaceae				
Argyrolobium	22	50	59	Ch, H
Trifolium	18	61	55	H
Geraniaceae				
Geranium	12	50	50	H, T
Gentianaceae				
Sebaea	35	54	46	H, T
Asclepiadaceae				
Schizoglossum	13	46	62	H
Rubiaceae				
Galium	13	77	54	Ch, H
Asteraceae				
Cineraria	20	50	60	Ch, H

e. Large genera with centres of diversity reported for Fynbos and Succulent Karoo

Family and genus	Total no. of taxa reported	% of reported taxa in: Fynbos	Succulent Karoo	Life form
Poaceae				
Ehrharta	29	90	45	H
Liliaceae				
Bulbine	23	65	48	Cr
Albuca	22	55	55	Cr
Amaryllidaceae				
Haemanthus	16	56	56	Cr
Gethyllis	11	82	45	Cr
Iridaceae				
Hesperantha	25	48	60	Cr
Babiana	51	57	49	Cr
Aizoaceae				
Pharnaceum	22	77	55	Ch, H, T
Tetragonia	27	56	67	Ch, H, T
Brassicaceae				
Heliophila	60	72	47	Ch, H, T
Fabaceae				
Wiborgia	10	70	80	Ch
Scrophulariaceae				
Diascia	11	45	50	H, T
Nemesia	39	62	46	Ch, H, T
Manulea	32	50	50	Ch, H, T
Selaginaceae				
Hebenstretia	23	57	48	Ch, H, T
Asteraceae				
Othonna	55	55	58	Ch, H, S
Arctotis	34	68	53	H
Gazania	18	61	61	H, T

f. Large genera with centres of diversity reported for Fynbos and Nama-Karoo

Family and genus	Total no. of taxa reported	% of reported taxa in: Fynbos	Nama-Karoo	Life form
Chenopodiaceae				
Salsola	24	58	63	Ch, H
Asteraceae				
Pteronia	52	46	42	Ch

g. Large genus with centres of diversity reported for Nama-Karoo and Succulent Karoo

Family and genus	Total no. of taxa reported	% of reported taxa in: Nama-Karoo	Succulent Karoo	Life form
Asteraceae				
Eriocephalus	19	63	58	Ch

h. Large genus with centres of diversity reported for Nama-Karoo and Desert

Family and genus	Total no. of taxa reported	% of reported taxa in: Nama-Karoo	Desert	Life form
Mesembryanthemaceae				
Psilocaulon	19	47	32	H, T

APPENDIX 3.—Large genera (10 taxa or more) with centres of diversity in three biomes. Life forms are abbreviated: P, phanerophyte; Ch, chamaephyte; H, hemicryptophyte; Cr, cryptophyte; T, therophyte; S, succulent

a. Large genera with centres of diversity reported for Savanna, Grassland and Fynbos

Family and genus	Total no. of taxa reported	% of reported taxa in: Savanna	Grassland	Fynbos	Life form
Fissidentaceae					
Fissidens	23	52	52	70	H
Celastraceae					
Maytenus	17	71	47	59	P, Ch
Asteraceae					
Conyza	13	62	54	92	Ch, H, T

b. Large genera with centres of diversity reported for Savanna, Nama-Karoo and Desert

Family and genus	Total no. of taxa reported	% of reported taxa in: Savanna	Nama-Karoo	Desert	Life form
Poaceae					
Stipagrostis	34	50	65	68	H
Pedaliaceae					
Sesamum	14	71	50	50	H, T

c. Large genus with centres of diversity reported for Fynbos, Succulent Karoo and Nama-Karoo

Family and genus	Total no. of taxa reported	% of reported taxa in: Fynbos	Succulent Karoo	Nama-Karoo	Life form
Zygophyllaceae					
Zygophyllum	30	50	53	57	Ch

d. Large genus with centres of diversity reported for Fynbos, Savanna and Nama-Karoo

Family and genus	Total no. of taxa reported	% of reported taxa in: Fynbos	Savanna	Nama-Karoo	Life form
Geraniaceae					
Monsonia	10	50	50	50	Ch,H,T,S

APPENDIX 4.—Large genera (10 taxa or more) with no apparent centre of diversity. Life forms are abbreviated: P, phanerophyte; Ch, chamaephyte; H, hemicryptophyte; Cr, cryptophyte; T, therophyte; S, succulent

Family and genus	Total no.	Vegetation type with largest % of taxa	%	Life form
Liliaceae *s.l.*				
Eriospermum	39	Savanna	41	Cr
Aloe	98	Savanna	44	Ch, S
Iridaceae				
Brunsvigia	11	Fynbos	36	Cr
Mesembryanthemaceae				
Ruschia	55	Fynbos	40	Ch, S
Fabaceae				
Lessertia	33	Fynbos	42	Ch, H
Asclepiadaceae				
Stapelia	27	Fynbos	44	H, S
Scrophulariaceae				
Sutera	72	Savanna	42	Ch, H, T
Campanulaceae				
Wahlenbergia	46	Grassland	35	H, T
Asteraceae				
Berkheya	43	Grassland	47	Ch, H

Bothalia 17,2: 229–235 (1987)

'n Kontrolelys van varings en blomplante van die Wonderkloof-natuurreservaat, Transvaal

J. P. KLUGE* en C. DYER**

Trefwoorde: checklist, Dicotyledoneae, Monocotyledoneae, Pteridophyta, South Africa, Transvaal

UITTREKSEL

'n Sistematiese lys van varings en blomplante word weergegee. Die verhoudings tussen die aantal families, genusse en spesies van Pteridophyta, Monocotyledoneae en Dicotyledoneae word aangetoon. Families wat meer as 1% tot die aantal spesies van die gebied bydra, en genusse wat meer as drie spesies bevat, word getabuleer.

ABSTRACT

A checklist of ferns and flowering plants of the Wonderkloof Nature Reserve — A systematic list of ferns and flowering plants of the Wonderkloof Nature Reserve is given. The relationships between the numbers of families, genera and species of Pteridophyta, Monocotyledoneae and Dicotyledoneae are indicated. Families contributing more than 1% to the total number of species of the area, and genera containing more than three species are tabulated.

Die Wonderkloof-natuurreservaat is tussen Nelspruit en Lydenburg, ongeveer 50 kilometer van Nelspruit in 'n noordwestelike rigting geleë en kom tussen 25° 15'–30' suiderbreedte en 30° 30'–45' oosterlengte voor. Die natuurreservaat is op die plaas Waterval 269 JT geleë, vorm 'n deel van die Uitsoekstaatsbos en beslaan 523 ha.

Die reservaat is teen die Transvaalse Drakensberg in die noordoostelike bergsuurveld (Acocks 1975) geleë en word gedreineer deur 'n ooswaarts vloeiende sytak van die Houtboschloop. Die reliëf in die reservaat is baie sterk en die hoogte bo seespieël wissel van 1 000 tot 1 300m bo seespieël.

Die geologiese formasie bestaan uit die Transvaal Sisteem en word op die reservaat deur die Pretoria Serie verteenwoordig. Die kranse, wat ook die boonste grens van die reservaat vorm, bestaan uit die boonste Nooitgedacht-kwartsiet. Direk onder die kranse kom die boonste skalie, voor of 'n gang van diabaas wat deur die reservaat voorkom en wat vir 'n kort ent direk onder die kranse verskyn. Die kranse teen die suidfront-helling word deur die onderste Nooitgedacht-kwartsiet gevorm. Die laerliggende oostelike deel van die reservaat bestaan uit skalie met sandsteenlae.

METODE

Planteksemplare is gedurende die periode 1974–1979 deur die senior outeur en mnr D. G. Ellan-Puttick versamel. Een stel eksemplare is aan die Nasionale Herbarium in Pretoria gestuur vir identifikasie en benaming terwyl 'n tweede stel in die Herbarium van die Departement van Bosbou by die D. R. de Wet Bosbounavorsingstasie gehuisves word. H. le Roux se eksemplare is in die Herbarium van die Laeveldse Botaniese Tuin.

RESULTATE EN BESPREKING

'n Totaal van 459 spesies is opgeteken. Die aantal families, genusse en spesies van die Pteridophyta, Monocotyledoneae en die Dicotyledoneae word in Tabel 1 aangegee.

Daar is 24 families, dit is 24% van die totale aantal families, waarvan die spesies meer as 1% van die totale aantal spesies verteenwoordig. In Tabel 2 word die families volgens grootte gelys. Die aantal genusse teenwoordig in die families word ook aangedui.

Die 17 genusse wat meer as 3 spesies behels, word in Tabel 3 gelys.

KONTROLELYS

Die versamelnommer volg elke takson. Versamelnommers van die senior outeur is met 'n K gemerk terwyl dié van D. G. Ellan-Puttick met 'n D gemerk is.

In die kontrolelys is die Pteridophyta gerangskik volgens Anthony & Schelpe (1985) en die Angiospermae volgens Dyer (1975, 1976). Die spesies is alfabeties gerangskik binne elke genus.

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* D. R. de Wet Bosbounavorsingstasie, Privaatsak X520, Sabie 1260. Tans: Laeveld Botaniese Tuin, Posbus 1024, Nelspruit 1200.

** D. R. de Wet Bosbounavorsingstasie, Privaatsak X520, Sabie 1260. Tans: Suid-Afrikaanse Navorsingsinstituut vir Bosbou, Posbus 727, Pretoria 0001.

TABEL 1.—Aantal families, genusse en spesies van Pteridophyta, Monocotyledoneae en Dicotyledoneae van die Wonderkloof-natuurreservaat

	Pteridophyta		Monocotyledoneae		Dicotyledoneae		Totaal
	No.	% van totaal	No.	% van totaal	No.	% van totaal	
Families	14	13,86	12	11,88	75	74,25	101
Genusse	18	5,88	62	20,26	226	73,85	306
Spesies	21	4,58	90	19,65	347	75,76	458

TABEL 2.—Aantal en persentasies van spesies en genusse van families waarvan die spesies meer as 1% van die totale aantal spesies van die Wonderkloof-natuurreservaat uitmaak

Familie	Aantal spesies	Aantal spesies uitgedruk as % van die totaal	Aantal genusse	Aantal genusse uitgedruk as % van die totaal
Fabaceae	51	11,20	28	9,18
Asteraceae	48	10,54	23	7,54
Poaceae	29	6,37	21	6,88
Rubiaceae	22	4,83	14	4,59
Liliaceae	14	3,07	10	3,27
Lamiaceae	14	3,07	8	2,62
Cyperaceae	13	2,85	9	2,95
Euphorbiaceae	13	2,85	7	2,29
Acanthaceae	11	2,41	8	2,62
Anacardiaceae	11	2,41	4	1,31
Iridaceae	10	2,91	6	1,96
Asclepiadaceac	10	2,19	3	0,98
Scrophulariaceae	9	1,97	8	2,62
Crassulaceae	7	1,53	2	0,65
Adiantaceae	6	1,31	4	1,31
Orchidaceae	6	1,31	5	1,63
Celastraceae	6	1,31	3	0,98
Malvaceae	6	1,31	3	0,98
Sterculiaceae	6	1,31	3	0,98
Convolvulaceae	6	1,31	3	0,98
Commelinaceae	5	1,09	3	0,98
Moraceae	5	1,09	1	0,32
Polygonaceae	5	1,09	2	0,65
Verbenaceae	5	1,09	4	1,31

TABEL 3.—'n Oorsig van die genusse met meer as drie spesies

Genus	Aantal spesies	Genus	Aantal spesies
Helichrysum	9	Ipomoea	4
Senecio	9	Maytenus	4
Rhus	7	Ochna	4
Vernonia	7	Pavetta	4
Indigofera	7	Plectranthus	4
Crassula	5	Polygala	4
Ficus	5	Rhynchosia	4
Gladiolus	5	Tephrosia	4
Eriosema	4		

PTERIDOPHYTA

SELAGINELLACEAE
Selaginella dregei *(Presl) Hieron.*

OPHIOGLOSSACEAE
Ophioglossum reticulatum *L., K 2351*

OSMUNDACEAE
Osmunda regalis *L., D 25*

SCHIZAEACEAE
Anemia dregeana *Kunze, K 1275*

GLEICHENIACEAE
Dicranopteris linearis *(Burm. f.) Underw., K 1146*

HYMENOPHYLLACEAE
Hymenophyllum capense *Schrad., K 1219*

CYATHEACEAE
Cyathea dregei *Kunze, K 2022*

DENNSTAEDTIACEAE
Pteridium aquilinum *(L.) Kuhn, K 1657*

ADIANTACEAE
Adiantum poiretii *Wikstr.* var. poiretii, *K 1318*

Cheilanthes
concolor *(Langsd. & Fisch.) Schelpe & N.C. Anthony, K 1019, 1416*
multifida *Swartz, K 1210*
Pellaea
calomelanos *(Swartz) Link, K 1611*
pectiniformis *Bak., K 2010*
viridis *(Forssk.) Prantl, K 1608*

POLYPODIACEAE
Polypodium polypodioides *(L.) Hitchc.* subsp. ecklonii *(Kunze) Schelpe, K 1633*
Pleopeltis macrocarpa *(Willd.) Kaulf., K 1216*

DAVALLIACEAE
Arthropteris monocarpa *(Cordem.) C. Chr., K 1320*
Oleandra distenta *Kunze, K 1018*

ASPLENIACEAE
Asplenium splendens *Kunze, D 55*

THELYPTERIDACEAE
Thelypteris gueinziana *(Mett.) Schelpe, K 1217, 1632*

BLECHNACEAE
Blechnum giganteum *(Kaulf.) Schlechtd., K 1218*

GYMNOSPERMAE

ZAMIACEAE
Encephalartos humilis *Verdoorn* *

ANGIOSPERMAE — MONOCOTYLEDONEAE

POACEAE
Imperata cylindrica *(L.) Raeuschel, D 88*
Eulalia villosa *(Thunb.) Nees, D 278, K 1665*
Schizachyrium sanguineum *(Retz.) Alst., K 1670*
Hyparrhenia
  filipendula *(Hochst.) Stapf* var. filipendula, *K 1153, 1662*
  variabilis *Stapf, K 1154*
Monocymbium ceresiiforme *(Nees) Stapf, K 1739*
Trachypogon spicatus *(L. f.) Kuntze, D 282*
Themeda triandra *Forssk., D 281*
Digitaria diagonalis *(Nees) Stapf, K 1224*
Brachiaria bovonei *(Chiov.) Robyns, K 1410*
Paspalum scrobiculatum *L., K 1411*
Oplismenus hirtellus *(L.) Beauv., K 1215*
Panicum
  dregeanum *Nees, D 314*
  sp. cf. fulgens *Stapf, D 284*
Panicum natalense *Hochst., K 1738*
Setaria
  megaphylla *(Steud.) Dur. & Schinz, K 1211*
  sphacelata *(Schumach.) Moss, K 1671*
Rhynchelytrum repens *(Willd.) C.E. Hubb., D 286*
Trichopteryx dregeana *Nees, K 1266*
Loudetia
  densispica *(Rendle) C.E. Hubb., D 280*
  simplex *(Nees) C.E. Hubb., D 283*
Phragmites australis *(Cav.) Steud., K 2118*
Aristida junciformis *Trin. & Rupr.* subsp. junciformis, *D 277*
Sporobolus
  centrifugus *(Trin.) Nees, K 1734*
  stapfianus *Gand., K 1412*
Eragrostis
  capensis *(Thunb.) Trin., K 1413*
  sp. cf. racemosa *(Thunb.) Steud., D 285*
  superba *Peyr., D 316*
Ctenium concinnum *Nees, D 279*

CYPERACEAE
Cyperus
  obtusiflorus *Vahl* var. flavissimus *Boeck., D 122*
  rupestris *Kunth, D 232*
Pycreus pelophilus *(Ridley) C.B. Cl., D 5*
Mariscus
  dregeanus *Kunth, K 1628*
  uitenhagensis *Steud., D 172, K 1406*
Kyllinga
  alba *Nees, D 58*
  melanosperma *Nees, K 1610*
Schoenoplectus corymbosus *(Roth. ex Roem. & Schult.) J. Raynal, D 148*
Fimbristylis bisumbellata *(Forssk.) Bub., D 41*
Bulbostylis burchellii *(Fic. & Hiern) C.B. Cl., D 256, K 1656, 1740*
Coleochloa setifera *(Ridley) Gilly, D 312*
Carex spicato-paniculata *C.B. Cl., K 1616*

XYRIDACEAE
Xyris
  capensis *Thunb., D 3*
  rehmannii *Nilss., K 1151*

COMMELINACEAE
Commelina
  africana *L., D 175, K 1155*
  erecta *L., D 176*
Aneilema hockii *De Wild., K 1751*
Cyanotis
  foecunda *Hassk., D 304*
  speciosa *(L.f.) Hassk., D 194*

JUNCACEAE
Juncus lomatophyllus *Spreng., D 147*

LILIACEAE
Androcymbium melanthioides *Willd.* forma subulatum *Bak., K 1667*
Anthericum
  angulicaule *Bak., D 66*
  galpinii *Bak., D 257, K 1653*
Eriospermum luteo-rubrum *Bak., D 306*
Aloe
  arborescens *Mill.* *
  petricola *Pole Evans**
Agapanthus inapertus *Beauv., K 1626*
Tulbaghia acutiloba *Harv., K 1404*
Dipcadi gracillimum *Bak., K 1405*
Ledebouria
  revoluta *(L.f.) Jessop, D 189*
  sp., *D 309*
Protasparagus
  aethiopicus *(L.) Oberm., K 1305*
  laricinus *(Burch.) Oberm., K. 1396*
Smilax kraussiana *Meisn., D 241*

AMARYLLIDACEAE
Clivia caulescens *R.A. Dyer, D 92*
Nerine rehmannii *(Bak.) L. Bol., D 267, 301*

HYPOXIDACEAE
Hypoxis
  filiformis *Bak., K 1402*
  multiceps *Buchinger, D 166*
  rigidula *Bak. D 49, K 1417*

VELLOZIACEAE
Xerophyta
  equisetoides *Bak., D 65*
  viscosa *Bak., K 1418*

DIOSCOREACEAE
Dioscorea
  cotinifolia *Kunth, D 236*
  rupicola *Kunth, K 1743*

IRIDACEAE
Moraea spathulata *(L. f.) Klatt, D 244*
Dietes iridioides *(L.) Sweet ex Klatt, D 96*
Aristea sp. cf. woodii *N.E. Br., D 269*
Crocosmia aurea *Planch., D 325*
Gladiolus
  crassifolius *Bak., D 8*
  elliotii *Bak., K 1652*
  exiguus *G.J. Lewis, D 275*
  longicollis *Bak., D 202*
  vernus *Oberm., K 1327*
Anomatheca laxa (*Thunb.) Goldbl., D 231*

ORCHIDACEAE
Holothrix orthoceras *(Harv.) Reichb. f., D 9*
Habenaria falcicornis *(Lindl. ex Lindl.) H.Bol.* var. caffra *(Schltr.) Renz & Schelpe, H. le Roux*
Disperis micrantha *Lindl., K 1213*
Polystachya
  albescens *Ridley* subsp. imbricata *(Rolfe) Summerh., K 1609*
  cultriformis *(Thouars) Spreng., K 1634*
Eulophia angolensis *(Reichb. f.) Summerh., K 1636*
Mystacidium venosum *Harv. ex Rolfe, K 1325*

DICOTYLEDONEAE

PIPERACEAE
Peperomia retusa *(L. f.) A. Dietr., K 1236*

ULMACEAE
Celtis africana *Burm. f., K 1399*

MORACEAE
Ficus
glumosa *(Miq.) Del., K 1737*
ingens *(Miq.) Miq., K 1229*
salicifolia *Vahl, K 1420*
sycomorus *L., K 1419*
thonningii *Blume, D 75, K 1421*

URTICACEAE
Laportea peduncularis *(Wedd.) Chew, K 1748*
Australina acuminata *Wedd., K 1747*

PROTEACEAE
Faurea
saligna *Harv., D 219*
speciosa *(Welw.) Welw., D 76*
Protea gaguedi *Gmel., K 1156*

SANTALACEAE
Osyridicarpos schimperianus *(Hochst. ex A. Rich.) DC., K 1621*
Thesium
sp. cf. resedoides *A.W. Hill, D 79*
sp. cf. utile *A.W. Hill, K 1622*

OLACACEAE
Ximenia caffra *Sond., K 1613*

POLYGONACEAE
Polygonum
meisnerianum *Cham. & Schlechtd., K 1663*
pulchrum *Blume, D 29*
salicifolium *Willd., D 31*
Oxygonum
sp. cf. dregeanum *Meisn.* var. dregeanum, *D 187*
dregeanum *Meisn.* var. strictum *(C.H. Wr.) R. Grah., D 128*

AMARANTHACEAE
Pupalia lappacea *(L.) Juss., K 1273, 1733*

CARYOPHYLLACEAE
Silene burchellii *Otth, D 261*

RANUNCULACEAE
Knowltonia transvaalensis *Szyszyl., D 220*

ANNONACEAE
Annona senegalensis *Pers., D 228*

LAURACEAE
Cryptocarya woodii *Engl., K 1270*

CAPPARACEAE
Cleome monophylla *L., D 288*

CRASSULACEAE
Kalanchoe
paniculata *Harv., K 1635*
rotundifolia *(Haw.) Haw., D 53*
Crassula
alba *Forssk.* var. alba, *D 10, K 1308*
globularioides *Britt.* subsp. argyrophylla *(Schonl. & Bak. f.) Toelken, D 109*
obovata *Haw.* var. obovata, *K 1668*
schimperi *Fischer & C.A. Mey.* var. lanceolata *(Eckl. & Zeyh.) Toelken, K 1223*
vaginata *Eckl. & Zeyh., K 1265*

ESCALLONIACEAE
Choristylis rhamnoides *Harv., K 28, 1276*

PITTOSPORACEAE
Pittosporum viridiflorum *Sims, D 97*

ROSACEAE
Rubus sp., *D 177*
Cliffortia strobilifera *Murray, K 1323*
Parinari capensis *Harv., D 111*

FABACEAE
Acacia
ataxacantha *DC., D 215*
caffra *(Thunb.) Willd., K 23, 1148*
karroo *Hayne, K 1149*
Elephantorrhiza elephantina *(Burch.) Skeels, D 149*
Bauhinia galpinii *N.E. Br., K 1615*
Cassia floribunda *Cav., K 1605*
Lotononis
corymbosa *Benth., D 274*
eriantha *Benth.* var. eriantha, *D 197*
Pearsonia
obovata *(Schinz) Polhill, D 21, 260*
sessilifolia *(Harv.) Duemmer* subsp. filifolia *(H. Bol.) Polhill, K 1226*
sessilifolia *(Harv.) Duemmer* subsp. marginata *(Schinz) Polhill, D 11, 22, 112*
Crotalaria
capensis *Jacq., D 230*
recta *Steud. ex A. Rich., K 1744*
Argyrolobium
speciosum *Eckl. & Zeyh., D 229*
tomentosum *(Andr.) Druce, D 19*
Lotus discolor *E. Mey., D 169*
Indigofera
adenoides *Bak. f., D 36*
hilaris *Eckl. & Zeyh., D 84*
masoniae *N.E. Br., K 1629*
melanadenia *Benth. ex Harv., K 1263*
pseudo-indigofera *(Merxm.) J.B. Gillett, D 300, K 1654*
sanguinea *N.E. Br., K 56*
swaziensis *H. Bol.* var. swaziensis, *D 208*
Tephrosia
cordata *Hutch. & Burtt Davy, D 320, K 1259*
longipes *Meisn.* var. lurida *(Sond.) J.B. Gillett, D 186, 253*
polystachya *E. Mey.* var. latifolia *Harv., K 1221*
retusa *Burtt Davy, D 254*
Aeschynomene micrantha *DC., D 247*
Stylosanthes fruticosa *(Retz.) Alston, D 37*
Zornia linearis *E. Mey., D 174, 252*
Desmodium
dregeanum *Benth., K 1222*
repandum *(Vahl) DC., D 16*
Pseudarthria hookeri *Wight & Arn., D 255*
Alysicarpus zeyheri *Harv., D 246*
Dalbergia armata *E. Mey., K 2117*
Pterocarpus angolensis *DC., D 117*
Abrus laevigatus *E. Mey., D 167, K 1207, 1220*
Dumasia villosa *DC.* var. villosa, *D 327*
Erythrina lysistemon *Hutch., K 1943*
Mucuna coriacea *Bak.* subsp. irritans *(Burtt Davy) Verdc., K 1943*
Rhynchosia
komatiensis *Harms, D 64*
monophylla *Schltr., D 60, 289*
reptabunda *N.E. Br., D 168*
totta *(Thunb.) DC., D 73*
Eriosema
angustifolium *Burtt Davy, D 191*
burkei *Benth., D 123, 178*
ellipticifolium *Schinz, K 2114*
psoraleoides *(Lam.) G. Don, D 222*
Flemingia grahamiana *Wight & Arn., D 93*
Vigna angustifoliolata *Verdc., D 173, K 1408*
Sphenostylis angustifolia *Sond., D 113*

GERANIACEAE
Geranium ornithopodium *Eckl. & Zeyh., D 52*
Monsonia attenuata *Harv., D 268*
Pelargonium
alchemilloides *(L.) L'Hérit., D 105*
luridum *(Andr.) Sweet, D 103*

OXALIDACEAE
Oxalis obliquifolia *Steud. ex A. Rich., K 1414*

LINACEAE
Linum thunbergii *Eckl. & Zeyh., D 211*

RUTACEAE
Zanthoxylum thorncroftii *(Verdoorn) Waterm., K 1143*
Vepris reflexa *Verdoorn, K 1235*
Clausena anisata *(Willd.) Hook. f. ex Benth., K 1214*

MELIACEAE
Ekebergia pterophylla *(C. DC.) Hofmeyr, D 120*

POLYGALACEAE
Polygala
albida *Schinz, D 321*
amatymbica *Eckl. & Zeyh., D 115*
hottentotta *Presl, D 259*
uncinata *E. Mey. ex Meisn., D 251, 296*

EUPHORBIACEAE
Phyllanthus
maderaspatensis *L., D 258*
nummulariifolius *Poir., K 2116*
Bridelia micrantha *(Hochst.) Baill., K 2122*
Acalypha
glandulifolia *Buchinger ex Meisn., D 179, 192, 311*
wilmsii *Pax ex Prain & Hutch., D 106*
Tragia rogersii *Prain, D 181, K 1397*
Jatropha
latifolia *Pax* var. latifolia, *K 1674*
latifolia *Pax* var. swazica *Prain, D 129*
Clutia
affinis *Sond., K 1617*
monticola *S. Moore, D 61*
pulchella *L., D 136, K 1607*
Euphorbia
ingens *E. Mey. ex Boiss.* *
pseudotuberosa *Pax, D 104*

ANACARDIACEAE
Harpephyllum caffrum *Bernh., K 1277*
Lannea
discolor *(Sond.) Engl., K 1735*
edulis *(Sond.) Engl., D 133*
Protorhus longifolia *(Bernh.) Engl., K 1278*
Rhus
chirindensis *Bak. f.* forma legatii *(Schonl.) R. & A. Fernandes, K 1230*
dentata *Thunb., D 152*
montana *Diels* var. gerrardii *(Harv. & Engl.) D. Fernandes, D 235*
pentheri *Zahlbr., K 1234, 1304*
pyroides *Burch., K 1147, 1664*
rehmanniana *Engl., K 1274*
rogersii *Schonl., D 170*

AQUIFOLIACEAE
Ilex mitis *(L.) Radlk., K 1630*

CELASTRACEAE
Maytenus
acuminata *(L. f.) Loes., K 1268*
heterophylla *(Eckl. & Zeyh.) N.K.B. Robson, K 2115*
peduncularis *(Sond.) Loes., K 1625*
undata *(Thunb.) Blakelock, K 1231*
Pterocelastrus echinatus *N.E. Br., D 98, 214*
Rhynea phyllicaefolia *(DC.) Hilliard & Burtt, D 27*

ICACINACEAE
Cassinopsis ilicifolia *(Hochst.) Kuntze, D 293*
Apodytes dimidiata *E. Mey. ex Arn.* subsp. dimidiata, *K 1279*

SAPINDACEAE
Pappea capensis *Eckl. & Zeyh., K 1228*
Hippobromus pauciflorus *(L. f.) Radlk., K 1227*

BALSAMINACEAE
Impatiens sylvicola *Burtt Davy & Greenway, K 1631*

RHAMNACEAE
Ziziphus mucronata *Willd.* subsp. mucronata, *K 1624*
Helinus integrifolius *(Lam.) Kuntze, D 242*

VITACEAE
Rhoicissus
tomentosa *(Lam.) Wild & Drumm., K 1612*
tridentata *(L.f.) Wild & Drumm., K 2119*
Cyphostemma
humile *(N.E. Br.) Desc.* subsp. dolichopus *(C.A. Sm.) Wild & Drumm., D 240*
woodii *(Gilg & Brandt) Desc., K 1415*

TILIACEAE
Corchorus asplenifolius *Burch., D 182*
Grewia occidentalis *L., D 156*
Triumfetta welwitschii *Mast.* var. hirsuta *(Sprague & Hutch.) Wild, D 90*

MALVACEAE
Sida
dregei *Burtt Davy, D 221*
hoepfneri *Guerke, D 35*
Pavonia
burchellii *(DC.) R.A. Dyer, K 1233*
columella *Cav., D 328*
Hibiscus
pedunculatus *L.f., D 320*
schinzii *Guerke, D 307*

STERCULIACEAE
Dombeya
pulchra *N.E. Br., K 22, 1745*
sp. cf. rotundifolia *(Hochst.) Planch.* var. rotundifolia, *D 81*
Hermannia
grandifolia *N.E. Br., D 33*
sp., *K 1736*
staurostemon *K. Schum., D 35A, 212*
Waltheria indica *L., D 295*

OCHNACEAE
Ochna
arborea *Burch. ex DC.* var. oconnorii *(Phill.) Du Toit, D 310*
confusa *Burtt Davy & Greenway, D 132*
natalitia *(Meisn.) Walp., D 153*
serrulata *(Hochst.) Walp., D 134*

CLUSIACEAE
Hypericum
aethiopicum *Thunb.* subsp. sonderi *(Bred.) N.K.B. Robson, D 85*
lalandii *Choisy, D 266*
revolutum *Vahl, D 151*

FLACOURTIACEAE
Dovyalis lucida *Sim, K 1212*
Rawsonia lucida *Harv. & Sond.* *

PASSIFLORACEAE
Basananthe sandersonii *(Harv.) De Wilde, D 249*
Adenia gummifera *(Harv.) Harms* var. gummifera, *K 1741*
Passiflora edulis *Sims, K 2120*

BEGONIACEAE
Begonia sutherlandii *Hook. f., D 317*

THYMELAEACEAE
Passerina montana *Thoday, D 146*

RHIZOPHORACEAE
Cassipourea gerrardii *(Schinz) Alston, K 1659*

COMBRETACEAE
Combretum
kraussii *Hochst., K 2013*
zeyheri *Sond., K 1745*

MYRTACEAE
Psidium guajava *L., K 2121*
Eugenia natalitia *Sond., K 1269*
Syzygium cordatum *Hochst., D 121*
Heteropyxis canescens *Oliv., K 1306*

MELASTOMATACEAE
Antherotoma naudinii *Hook. f., D 40*
Dissotis canescens *(E. Mey. ex Grah.) Hook. f., D 7*

ONAGRACEAE
Epilobium salignum *Hausskn., K 1319*
Oenothera rosea *L'Hérit. ex Ait., D 213*

ARALIACEAE
Cussonia spicata *Thunb., K 1400*

APIACEAE
Centella asiatica *(L.) Urb., K 2012*
Heteromorpha involucrata *Conr., D 319*
Annesorrhiza flagellifolia *Burtt Davy, D 118*

ERICACEAE
Erica drakensbergensis *Guth. & Bol., D 108*

MYRSINACEAE
Maesa lanceolata *Forssk., D 225*

SAPOTACEAE
Bequaertiodendron magalismontanum *(Sond.) Heine & J.H. Hemsl., D 77*

EBENACEAE
Euclea crispa *(Thunb.) Guerke* subsp. crispa, *D 91*
Diospyros
galpinii *(Hiern) De Winter, D 126*
whyteana *(Hiern) F. White, K 2014*

OLEACEAE
Schrebera alata *(Hochst.) Welw., K 1742*
Jasminum streptopus *E. Mey.* var. transvaalensis *(S. Moore) Verdoorn, D 233*

LOGANIACEAE
Strychnos madagascariensis *Poir. K 1614*
Nuxia congesta *R. Br. ex Fresen., D 82*
Buddleja salviifolia *(L.) Lam., D 80*

PERIPLOCACEAE
Cryptolepis oblongifolia *(Meisn.) Schltr., D 125, 315*
Raphionacme hirsuta *(E. Mey.) R.A. Dyer ex Phill., D 119*

ASCLEPIADACEAE
Schizoglossum pachyglossum *Schltr.* var. productum *N.E. Br., K 1666*
Pachycarpus transvaalensis *N.E. Br., D 201*
Asclepias
aurea *(Schltr.) Schltr., D 195*
physocarpa *(E. Mey.) Schltr., K 1606*
Sarcostemma viminale *(L.) R. Br., K 1661*
Brachystelma macropetalum *(Schltr.) N.E. Br., K 1672*
Ceropegia
meyeri *Decne., K 1150*
racemosa *N.E. Br.* subsp. setifera *(Schltr.) Huber, K 1267*
Riocreuxia torulosa *Decne., D 237*
Sphaerocodon natalense *(Meisn.) Hook. f., D 223*

CONVOLVULACEAE
Merremia tridentata *(L.) Hall. f.* subsp. angustifolia *(Jacq.) Ooststr. D 38*
Ipomoea
atherstonei *Bak., D 162*
bolusiana *Schinz, D 100*
sp. cf. ommaneyi *Rendle, D 161*
plebeia *R. Br.* subsp. africana *A. Meeuse, D 4*
Turbina oblongata *(E. Mey. ex Choisy) A. Meeuse, D 150, 160*

BORAGINACEAE
Trichodesma physaloides *(Fenzl) A. DC., D 292*
Cynoglossum lanceolatum *Forssk., D 243*

VERBENACEAE
Verbena bonariensis *L., D 6*
Lantana rugosa *Thunb., D 87, 157*
Lippia wilmsii *Pearson, D 101, 297*
Clerodendrum
glabrum *E. Mey., K 1232, 1623*
triphyllum *(Harv.) Pearson, K 2019*

LAMIACEAE
Acrotome hispida *Benth., D 114, K 1409*
Stachys
grandifolia *E. Mey. ex Benth., D 326*
natalensis *Hochst.* var. natalensis, *K 1750*
Aeollanthus rehmannii *Guerke, D 308*
Pycnostachys
reticulata *(E. Mey.) Benth., K 1260*
urticifolia *Hook., D 224*
Plectranthus
fruticosus *L'Hérit., K 1264*
laxiflorus *Benth. D 32*
rubropunctatus *Codd, K 1209*
verticillatus *(L. f.) Druce, D 17*
Iboza riparia *(Hochst.) N.E. Br., K 1328*
Hemizygia transvaalensis *(Schltr.) Ashby, D 47, 83, K 24*
Becium obovatum *(E. Mey. ex Benth.) N.E. Br., D 71, 116*
Orthosiphon serratus *Schltr., D 154, K 1619*

SOLANACEAE
Physalis peruviana *L., D 143*
Solanum retroflexum *Dun., K 1749*

SCROPHULARIACEAE
Halleria lucida *L., D 99*
Phygelius aequalis *Harv. ex Hiern, D 137*
Bowkeria cymosa *MacOwan, K 1262*
Sutera grandiflora *(Galpin) Hiern, D 14*
Ilysanthes wilmsii *Engl., D 2*
Graderia subintegra *Mast., D 72*
Sopubia simplex *(Hochst.) Hochst., D 42, 139, 276*
Striga
asiatica *(L.) Kuntze, D 34, 302*
bilabiata *(Thunb.) Kuntze, D 216*

SELAGINACEAE
Hebenstretia
integrifolia *L., D 135*
sp., *D 107*
Selago elata *Rolfe, K 1261*
Tetraselago natalensis *(Rolfe) Junell, D 265*

PEDALIACEAE
Ceratotheca triloba *(Bernh.) Hook. f., D 13*

GESNERIACEAE
Streptocarpus cyaneus *S. Moore, K 1208*

ACANTHACEAE
Thunbergia
atriplicifolia *Nees, D 63*
natalensis *Hook. D 155*
neglecta *Sond., D 227*
Crabbea hirsuta *Harv., D 329*
Barleria ovata *E. Mey. ex Nees, D 263*
Sclerochiton harveyanus *Nees, D 324*
Crossandra greenstockii *S. Moore, D 238*
Dicliptera clinopodia *Nees, D 39*
Hypoestes
aristata *R. Br., K 1317*
phaylopsoides *S. Moore, D 18*
Justicia anagalloides *T. Anders., D 180, K 1407*

PLANTAGINACEAE
Plantago major *L., K 1321*

RUBIACEAE
Kohautia
lasiocarpa *Klotzsch, D 217*
virgata *(Willd.) Brem., D 313*
Oldenlandia herbacea *(L.) Roxb., D 1, 44, 305, K 1655*
Breonadia salicina *(Vahl) Hepper & Wood, K 2021*
Cephalanthus natalensis *Oliv., D 140*
Rothmannia globosa *(Hochst.) Keay, D 322*
Tricalysia
capensis *(Meisn.) Sim, D 95*
lanceolata *(Sond.) Burtt Davy, K 1658*

Pentanisia
angustifolia *(Hochst.) Hochst., D 205*
prunelloides *(Klotzsch ex Eckl. & Zeyh.) Walp., D 62*
Vangueria infausta *Burch., D 171*
Canthium
gueinzii *Sond., D 94, 142, K 25*
inerme *(L. f.) Kuntze, K 1620, 1660*
Fadogia tetraquetra *Krause, D 299*
Pavetta
assimilis *Sond.* var. assimilis, *K 1307*
gardeniifolia *Hochst. ex A. Rich., K 1627*
cooperi *Harv. & Sond., D 165*
edentula *Sond., D 239*
Psychotria capensis *(Eckl.) Vatke, D 74*
Anthospermum
bispidulum *E. Mey. ex Harv. & Sond., D 294, 303, K 1237*
rigidum *Eckl. & Zeyh., D 245*
Richardia brasiliensis *Gomez, D 318*

DIPSACACEAE
Cephalaria pungens *Szabo, K 1142*
Scabiosa columbaria *L., D 48*

CUCURBITACEAE
Momordica foetida *Schum. & Thonn., D 287*
Coccinia
adoensis *(Hochst. ex A. Rich.) Cogn., D 226*
palmata *(Sond.) Cogn., K 1152*

CAMPANULACEAE
Wahlenbergia zeyheri *Eckl. & Zeyh., D 246*
Lightfootia paniculata *Sond., D 78*

LOBELIACEAE
Lobelia decipiens *Sond., D 138, 262, K 1401*

ASTERACEAE
Vernonia
galpinii *Klatt, D 248*
hirsuta *(DC.) Sch. Bip., D 89*
natalensis *Sch. Bip., D 203*
neocorymbosa *Hilliard, K 1271*
poskeana *Vatke & Hildebr., D 51*
stipulacea *Klatt, K 2126*
sutherlandii *Harv., K 29*
Stomatanthes africanus *(Oliv. & Hiern) R.M. King & H. Robinson, D 130*
Mikania natalensis *DC., K 1949*
Aster
comptonii *Lippert, D 234*
lydenburgensis *Lippert, D 45, 69*
Felicia mossamedensis *(Hiern) Mendonça, D 46, 70*
Nidorella auriculata *DC.* subsp. auriculata, *D 207*
Conyza pinnata *(L. f.) Kuntze, D 198*
Blumea alata *(D. Don) DC., D 291*
Helichrysum
aureum *(Houtt.) Merr., D 20*
cephaloideum *DC., D 144, K 1669*
kraussii *Sch. Bip., K 1951*
nudifolium *(L.) Less.* var. nudifolium, *D 210, K 1144*
oxyphyllum *DC., D 86*
pilosellum *(L. f.) Less., D 59*
rugulosum *Less., D 206, K 1225*
splendidum *(Thunb.) Less., D 127*
harveyanum *Wild, D 273*
Athrixia phylicoides *DC., D 26*
Geigeria burkei *Harv.* subsp. burkei var. burkei, *D 28*
Callilepis laureola *DC., D 102*
Anisopappus smutsii *Hutch., K 1326*
Acanthospermum australe *(Loefl.) Kuntze, D 272*
Inezia integrifolia *(Klatt) Phill., D 183*
Schistostephium crataegifolium *(DC.) Fenzl ex Harv., D 15, 24*
Crassocephalum picridifolium *(DC.) S. Moore, K 1324*
Senecio
bupleuroides *DC., D 271*
coronatus *(Thunb.) Harv., D 131*
deltoideus *Less., K 1946*
inornatus *DC., K 1303, 1322*
glaberrimus *DC., D 218*
microglossus *DC., D 163, K 1673*
pterophorus *DC., D 30, 54*
striatifolius *DC., K 1145*
tamoides *DC., K 26*
Euryops pedunculatus *N.E. Br., K 1272*
Osteospermum jucundum *(Phill.) T. Norl., D 68*
Berkheya insignis *(Harv.) Thell., D 124*
Dicoma
anomala *Sond.* subsp. cirsioides *(Harv.) Wild, D 23*
zeyheri *Sond., D 250*
Gerbera
ambigua *(Cass.) Sch. Bip., D 57, 60*
jamesonii *H. Bol. ex Hook. f., D 67*

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A checklist of vascular plants of the Amatole Mountains, eastern Cape Province/Ciskei

P. B. PHILLIPSON*

Keywords: Amatole Mountains, checklist, Ciskei, eastern Cape Province, southern Africa, vascular plants, Winterberg

ABSTRACT

A checklist of vascular plants of the Amatole Mountains is presented. The physical environment, climate and vegetation of the study area and the history of its botanical exploration are described. The mountains form part of the Winterberg Range in the eastern Cape/Ciskei region of south-eastern Africa, and cover an area of approximately 900 km^2. The altitude ranges from about 700 m to 2 000 m above sea level, and the topography is very varied. The climate is warm temperate and supports various vegetation types including forest, sclerophyllous shrubland, grassland and marshland. The checklist records the occurrence of 1 215 taxa. The largest families and genera in the area contain predominantly grassland herbs. Many of the characteristic families of the Cape Floristic Region and of the arid areas of southern Africa are poorly represented in the Amatole Mountains.

UITTREKSEL

'n Kontrolelys van vaatplante van die Amatoleberge word verskaf. Die fisiese omgewing, klimaat en plantegroei van die studiegebied en die geskiedenis van die plantkundige verkenning daarvan, word beskryf. Hierdie berge vorm deel van die Winterberg-reeks in die Oos-Kaap/Ciskei-gebied van suidoostelike Afrika en beslaan ongeveer 900 km^2. Die hoogte bo seespieël strek vanaf ongeveer 700 m tot 2 000 m en die topografie is baie variërend. Die klimaat is warm gematig en onderhou verskeie plantegroeitipes waaronder woud, sklerofiele struikveld, grasveld en vleiland. Daar is 1 215 taksons op die kontrolelys aangeteken. Die grootste families en genusse in die gebied bevat oorwegend grasveldkruide. Baie van die kenmerkende families van die Kaapse Flora-gebied en van die dorre gebiede van die suidelike Afrika is swak verteenwoordig in die Amatoleberge.

INTRODUCTION

The Amatole Mountains in the south-east of southern Africa are of particular botanical and ecological interest for a number of reasons. The Mountains lie in a region where six major African phytochoria meet. These are the Indian Ocean Coastal Belt, the Sudano-Zambezian Region, the Karoo-Namib Region, the Cape Region and the Afro-montane archipelago with its associated Afro-alpine areas (Werger 1978). The Mountains receive a relatively high rainfall, and act as an important drainage sponge for the neighbouring lower lying semi-arid areas. The indigenous forests and marshlands are believed to be particularly important in this respect.

State forestry plantations and residential areas are responsible for the introduction of many exotic species, some of which have become naturalized. The establishment of forest plantations and the encroachment of exotics into natural vegetation have had a very significant effect on the indigenous flora and on the ecology of the area as a whole.

The Amatole Mountains have been known to botanists since the early nineteenth century, and have gradually become relatively thoroughly explored. They have long been recognized as an area with a high species diversity, but little precise information has been available about their flora.

The aim of this work is to provide a reliable and comprehensive checklist of the vascular plants of the Amatole Mountains which can serve as a basic reference for taxonomic, floristic and ecological research, and for educational purposes in the future.

STUDY AREA

Physical Environment

The name Amatole (or Amatola) Mountains has been applied to a vaguely-defined section of the Winterberg Range, centred on the well known Hogsback Ridges. In the present study they are defined as bounded by the Kat and Esk Rivers in the north-west and the Thomas and Keiskamma Rivers in the east. The bottom edge of the escarpment forms the southern edge, while an arbitrary line across the African surface plateau connecting the Esk and Thomas Rivers forms the northern boundary (Figure 1). Defined in this way the Amatole Mountains form an area of about 900 km^2, lying within the latitudes 32° and 33° S, and longitudes 26° and 28° E.

The Amatole Mountains are part of a long outlying spur of the high interior plateau of southern Africa. The spur extends south-east and then east from the Great Escarpment, gradually loosing height and disappearing near the town of Stutterheim. It has been breached by the Fish River, which separates the Amatoles and other mountains of the Winterberg Range to the east from the Bankberg, Bruintjeshoogte and Tandjesberg Ranges to the west.

The Winterberg Range has a steep, irregular escarpment facing south, which rises above the 'Post-African' erosion surface. To the north of the escarp-

* Formerly: Department of Botany, University of Fort Hare, Alice, Ciskei.

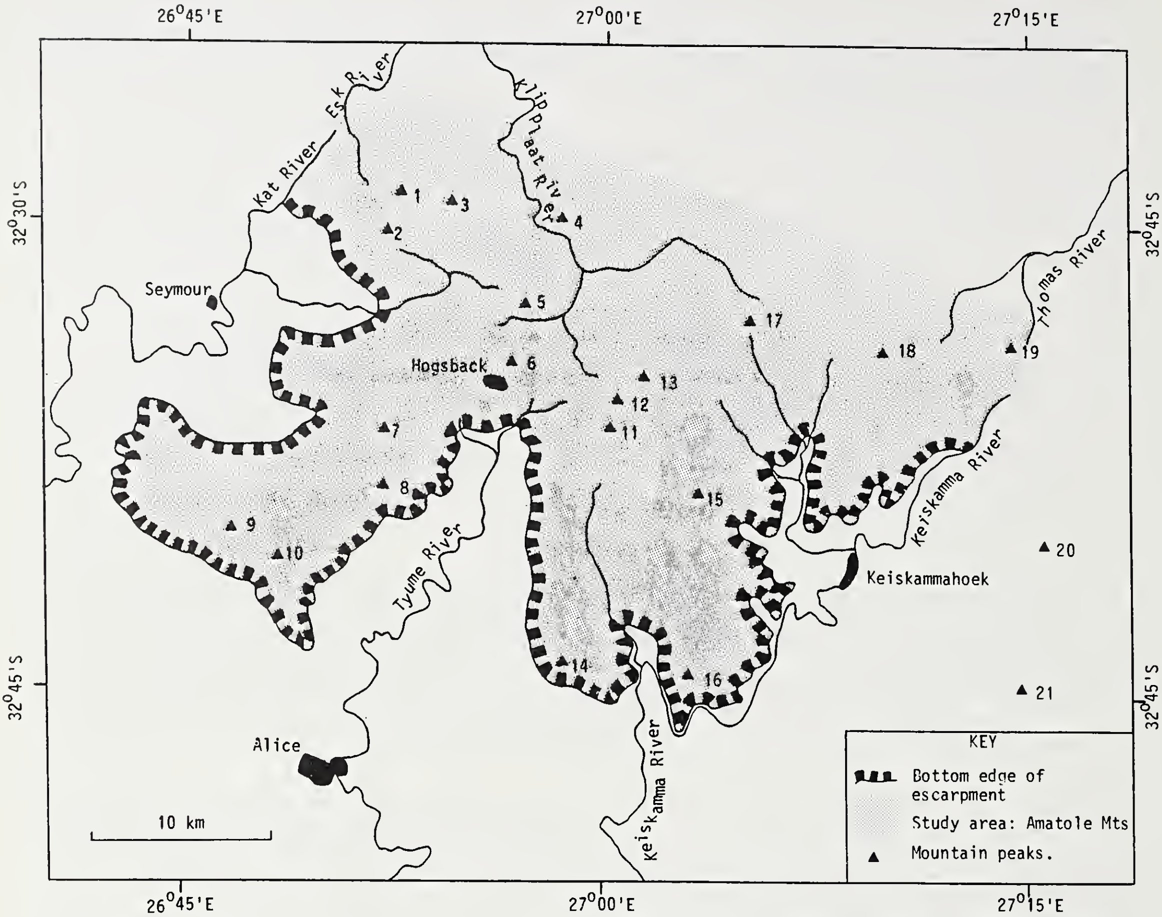

FIGURE 1. — Map of the study area showing the main mountain peaks, rivers and settlements. Amatole Mountains, main peaks: Elandsberg 1(2 017 m), 2(1 960 m), 3(1 877 m); unnamed, 4(1 800 m); Gaika's Kop 5(1 963 m); Tor Doone 6(1 565 m); Menziesberg, 7(1 645 m); Pefferskop, 8(1 086 m); Juanasberg, 9(1 411 m), Tyume Peak 10(1 481 m); Hogsback Peaks, 11(1 836 m), 12(1 826 m), 13(1 937 m); Iron Rock, 14(1 089 m); Gxulu Kop, 15(1 427 m); Mount Macdonald, 16(991 m); Geju Mountain, 17(1 868 m); Cata Mountain, 18(1 641 m); Mount Thomas 19(1 616 m). Pirie Mountains, main peaks: Mount Kempt, 20(1 420 m); Pirie Mountain, 21(1 270 m).

ment, the land, which forms part of the older 'African' erosion surface, slopes gradually into the basins of the Fish and Kei Rivers. Remnants of the still older 'Gondwana' erosion surface remain as scattered peaks, ridges and mesas above the African surface plateau.

The escarpment of the Amatole Mountains falls from the African surface plateau at about 1 500 m to between 700 and 1 000 m, broken in many places by an intermediate platform at about 1 250 m. Above the plateau the highest mountain peaks reach about 2 000 m. The most prominent of the peaks are shown in Figure 1.

The Winterberg Range consists of dolerite sheets, dikes and sills intruded into weak shales and sandstones of the Karoo sequence (Beaufort Group). The resistant dolerite has strongly influenced the landscape, helping to maintain the prominent escarpment and the Gondwana remains, and also causing a number of less important features. The geomorphology of the Hogsback area was described in more detail by Agnew (1958).

Climate

The climate of the Amatole Moutains is warm temperate, characterized by high rainfall, cold winters and moderately warm summers relative to other parts of southern Africa.

Moist air from the south is forced upwards by the escarpment and results in rainfall of between 750 and 1 500 mm per annum, increasing from lower to higher altitudes (Story 1952). Behind the escarpment and on north-facing slopes the rain shadow decreases the rainfall, while local topographic effects may increase it in certain places. Rainfall is more evenly spread throughout the year than is common in many parts of southern Africa, although it is highest in summer, with a peak in February. On the escarpment and south-facing mountain slopes fog is common, and mist gauges have recorded 20 – 30% gains over the standard precipitation (S. Russell pers. comm.).

At the Hogsback settlement (about 1 250 m) the annual average temperature is about 15 °C, with absolute maxima and minima of 40° in summer and -6°

in winter respectively, with some snow falling in most years. Obviously altitude and topography influence temperatures, and very much colder conditions are found at the summits of the main peaks.

Vegetation

The vegetation of the Amatole Mountains is predominantly Afro-montane in affinity (White 1978, 1983), and many typical Afro-montane species reach their southern limit in this region. In addition the Mountains contain a significant Cape element in their flora, together with many SE African endemics. They fall within an area of Highland and Dohne Sourveld in the vegetation classification of Acocks (1975).

The high rainfall in the Amatole Mountains is able to support well developed high forest. These forests are floristically rich, containing both evergreen and deciduous species, with large specimens of *Podocarpus falcatus* being particularly prominent. Well preserved forest is present on most of the escarpment slopes, and in some areas of the intermediate platform. On the mountain peaks, above the plateau, some forest/woodland patches are found in sheltered areas, mainly in south-facing positions. These patches are poor in species and are probably above the altitudinal limit for many forest tree species in this region.

The plateau areas and mountain slopes are largely grass-covered. This 'sour' grassland has provided good grazing land for domestic stock, and this has given rise to the Mountains' name. Amatole (or Amatola) is derived from the Xhosa word *amathole,* the plural of *ithole,* meaning calves. Oral history describes the large herds of cattle owned by pastoralists in the days of Paramount Chief Sandile. These herds thrived on the rich grassland and produced many calves, and the area eventually became known as the 'mountains of calves' *(iintabe zakwamathole)* (Pahl pers. comm.). Excessive grazing by domestic stock can severely reduce grass cover, and this may lead to soil erosion. Serious erosion has occurred in some localities, particularly near the base of the escarpment. At higher altitudes bare ground does not appear prone to excessive erosion, and is usually colonized by unpalatable herbs and small shrubs which help to stabilize the soil surface. *Helichrysum argyrophyllum,* in particular, covers large areas that have been overgrazed, and once it is established, regrowth of grasses appears to be very slow. Grassland in the Amatole Mountains contains a large number of herbs which are highly responsive to fire, being inconspicuous in moribund grassland, but flowering prolifically after burning.

In many places the vegetation is dominated by sclerophyllous shrubs growing up to about 3 m tall. Such areas are relatively poor in species, with *Cliffortia* spp., *Erica brownleeae, Passerina* spp. and *Stoebe* spp. predominating. These communities are often referred to as 'false-macchia' to distinguish them from the true macchia (fynbos) of the Cape region and can colonize grassland areas very rapidly. It is not certain whether they represent a climax stage, or merely a step in the succession from grassland to forest. In many localities old stands of false-macchia may contain forest pioneer species such as *Buddleja salvifolia, Halleria lucida* and *Rapanea melanophloeos,* and probably in the more sheltered localities the succession could procede to forest, while in the more exposed areas a mixed false-macchia/woodland may result. The false-macchia communities are very sensitive to fire, and controlled burning programmes have been employed successfully in eliminating sclerophyllous shrubs and promoting the re-establishment of pasture grasses. Overgrazing pratices may encourage the encroachment of false-macchia. The agricultural management of vegetation in the Amatole Mountains has been discussed by Trollope (1973).

The summits of the highest peaks reach into the Sub-alpine Belt of the Afro-alpine Region (Killick 1978), where a montane moorland vegetation occurs. On rocky areas this consists of small sclerophyllous shrubs, growing to a height of about 0,5 m, often with scattered small trees of *Protea subvestita.* These shrubs may include *Arrowsmithia styphelioides, Chrysocoma tenuifolia, Cliffortia paucistaminea, Erica* spp., *Euryops dyeri, Muraltia* spp. and *Passerina montana,* with *Restio sejunctus* and *Thamnocalamus tesselata* also common. Elsewhere on the summits grassland may occur with *Agrostis* spp., *Aristida junciformis* subsp. *galpinii* and *Festuca* spp. predominating. Little is known about the ecology of the summit vegetation.

Depressions in level areas may support patches of marshland. These are usually dominated by species of Cyperaceae, although the invasion of some marshes near Gaika's Kop by *Phragmites australis* has been noted.

Man has certainly had a significant influence on the vegetation of the Amatole Mountains over a long period of time. Since about 1850 forestry activities and the development of the Hogsback residential/recreational area have caused the introduction of a large number of exotic species. A number of economically important forest trees have been planted in the region, and some of these have become naturalized. The Hogsback settlement is well known as a place where temperate garden plants will flourish, and some of these have also become naturalized. Most of the naturalized exotics in the Amatole Mountains are confined to disturbed ground near plantations and cultivated ground, and most have failed to encroach significantly on the natural vegetation. Important exceptions are *Acacia mearnsii, Pinus* spp., *Rubus fruticosus* and certain grasses, notably *Stipa trichotoma,* which have become widespread.

HISTORY OF BOTANICAL EXPLORATION IN THE AMATOLE MOUNTAINS

The earliest known preserved botanical specimens from the Amatole Mountains are those collected by C. F. Ecklon and C. L. P. Zeyher in 1831/2. Their contemporary, J. F. Drège, and earlier collectors such as W. J. Burchell and C. P. Thunberg collected in neighbouring areas, but did not actually visit the Amatole Mountains (Gunn & Codd 1981). Ecklon and Zeyher collected on 'Schumiberg', the mountain

now known as Juanasberg. While collecting in the area they probably stayed at Tyumie Mission, which had been founded by Rev. J. Brownlee in 1820. Brownlee was himself a keen amateur botanist, but he only started preserving plant specimens after moving to King William's Town in 1825 (Gunn & Codd 1981). During this early period the Amatole Mountains must have been very inaccessible, and further botanical exploration was probably prevented by the series of frontier wars which continued until 1847. In 1860 T. Cooper visited the area, and collected extensively, particularly on Elandsberg.

Soon a number of forest stations were set up along the Winterberg, and gradually the mountains became more accessible (Sim 1907). As botanical exploration of southern Africa proceeded, many important collectors of the late nineteenth century visited parts of the Winterberg, but little material was collected in the Amatole Mountains. The Pirie Mountains in the east, and the Boschberg to the west of the Winterberg were extensively explored by T. R. Sim and P. Macowan respectively. J. Buchanan collected grasses and ferns in the Amatole Mountains while he was stationed at Lovedale Mission from 1876 to 1877, and Sim and W. G. Bennie also made some collections in the area (Sim 1915; Gunn & Codd 1981). However, in general the flora of the area remained poorly known.

In the early part of the twentieth century G. Rattray made extensive collections in the Amatole Mountains, mainly at Hogsback, and some other important collectors visited the area at this time. In 1934 systematic botanical exploration of the Mountains commenced with the appointment of M. H. Giffen as the lecturer in Botany at the nearby South African Native College (now the University of Fort Hare). Giffen collected extensively during the 1930's and 1940's but unfortunately did not distribute duplicate specimens. His main interest was in diatoms and his collections of other plant groups did not receive the attention they deserved (M.H. Giffen pers. comm.).

In 1947 R. Story commenced a botanical survey of the Keiskammahoek District, which includes a portion of the Amatole Mountains, but also includes part of the Pirie Mountains and some lower lying areas (Story 1952). This work is important, not only with respect to the specimens collected, but also in providing a basic ecological account of the District.

Since the mid-1950's regular student field excursions to the Hogsback area have been organized by A. R. A. Noel, A. Jacot Guillarmod and R. A. Lubke of Rhodes University, Grahamstown, which formed the basis of an unpublished checklist. Specimens collected on these visits are housed at RUH, but have not been critically identified. Since 1975 staff and students at the University of Fort Hare have continued collecting in the Amatole Mountains, and a number of ecological research projects have been carried out. Field work undertaken for the present study was concentrated on the more poorly collected localities, habitats and taxa, in order to give a more thorough coverage of the flora of the area. The Giffen collections were finally identified and labelled and his duplicate specimens and other collections were distributed by G. E. Gibbs Russell. By July 1986 nearly 3000 specimens of vascular plants from the Amatole Mountains had accumulated in the Herbarium of the Department of Plant Sciences at the University (UFH), and these form the basis of the present checklist.

The Amatole Mountains have been visited by many botanists from other institutions during the past 20 to 30 years, and they have become botanically well explored in comparison with many areas of southern Africa.

CHECKLIST

The present checklist of vascular plants was compiled from a number of sources. The specimens at UFH have been examined and identified using the relevant Floras and monographs. In problematic cases comparison of material with authentically determined specimens in other herbaria has been made. In many cases, specimens of taxa currently under revision have been seen by or discussed with the taxonomists concerned. Specimens at UFH thus form the basis of the checklist. Duplicate material has been distributed to many other herbaria, but the main duplicate sets are held at K, MO and PRE.

Records of additional taxa have been obtained directly from taxonomic literature where a locality within the study area has been specifically mentioned. An extensive search of the available literature was made for such records, and these have been cited in full in the checklist.

No attempt has been made to systematically search for material from the Amatole Mountains in other herbaria, however a comparison was made with the computerized record (PRECIS) of the collections at PRE. Duplicates of the historically important Cooper, Sim and Rattray collections, together with many recent collections, are listed and these were checked against the present checklist. In a sample section of about a sixth of the PRECIS record no additional taxa were found.

In the course of field work for the present study a few sight records of additional taxa were made, and these are given in the checklist.

Nomenclature follows the list of accepted taxa at PRE (Gibbs Russell *et al.* 1984, 1985), except where more recent treatments are available. Every effort has been made to ensure that the checklist was taxonomically and nomenclaturally up-to-date on completion in December 1986.

DISCUSSION

The checklist includes 1 215 taxa, 65 pteridophytes, 4 gymnosperms, 328 monocots and 818 dicots. The largest families (with over 50 taxa) are the Asteraceae (208 taxa, 17%), Poaceae (83 taxa, 7%), Fabaceae (67 taxa, 6%), Cyperaceae (62 taxa, 5%), Liliaceae (54 taxa, 4%) and Orchidaceae (53 taxa,4%). The two largest genera are *Senecio* (50 taxa, 4%) and *Helichrysum* (49 taxa, 4%), both members of the Asteraceae. No other genus has

more than 14 recorded taxa, but the following have 10 or more: *Argyrolobium, Asplenium, Cheilanthes, Crassula, Disa, Erica, Geranium, Hypoxis, Indigofera, Pelargonium, Rhus, Stachys* and *Wahlenbergia.*

Most of the largest families and genera are groups containing predominantly grassland herbs, notably the Asteraceae and the Poaceae, and this reflects the high diversity of species found in this habitat in the Amatole Mountains. There is also a large number of species of Cyperaceae, a family characteristic of marshland habitats. Taxa typical of forest habitats are only represented, in these figures, by the relatively small genera *Asplenium* and *Cheilanthes* (both Pteridophytes), and the sclerophyllous vegetation only by the genus *Erica.*

Comparison of the figures given above with those given by Goldblatt (1978) for the whole of southern Africa show some similarities in the relative proportions of many taxa. The most noticeable differences in the flora of the Amatole Mountains is the low number of species of Ericaceae, Proteaceae and Restionaceae, characteristic families of the Cape Floral Region, and of Mesembryanthemaceae (included in Aizoaceae by Goldblatt), which are concentrated in arid areas.

Some specimens belonging to genera which are currently in a state of taxonomic confusion or currently under revision could not be identified, these include *Alchemilla, Erica, Harveya, Hypoxis, Indigofera, Lotononis, Pentaschistis, Senecio* and *Wahlenbergia.* Other genera contain probable new species, these include *Cliffortia, Cineraria, Conium, Crassula, Fuirena, Helichrysum, Passerina, Pentzia, Stoebe* and *Watsonia.* Some naturalized exotics recorded in the Amatole Mountains, but lacking voucher specimens, were not identified to species level, and the record of *Othonna* sp. is based on an unsubstantiated literature reference. In some cases, specimens of species divided into varieties or subspecies could not be assigned to these taxa with certainty.

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CHECKLIST

The checklist is divided into four sections: section 1 deals with the Pteridophyta, each genus prefixed with 'P' and numbered according to the sequence in Anthony & Schelpe (1985); sections 2, 3 and 4, which deal with the Gymnospermae, Angiospermae–Monocotyledoneae and Angiospermae–Dicotyledoneae respectively, are numbered according to the system used in the *Flora of southern Africa* (Dyer 1975, 1976). This is based on that of De Dalle Torre & Harms (1963), except the Poaceae which are numbered according to the Kew system, each genus prefixed with 'K'. In the checklist the voucher specimens cited are specimens at UFH, unless otherwise stated or unless a literature citation is given. The following abbreviations for collectors's names are used: *Br* = E.D. Brown, *Fu* = H.D. Furness, *GR* = G.E. Gibbs Russell, *Gi* = M.H. Giffen, *Hu* = A. Hutchings, *Ph* = P.B. Phillipson and *Tu* = M. Tusenius.

PTERIDOPHYTA

LYCOPODIACEAE
P2 Lycopodium
clavatum *L. Fu & Ph 146; GR 3481; Gi 36, 235, 582; Ph 408; Rayment s.n.*
gnidioides *L. f. Gi 236, 1050, 1569, s.n.; Grierson s.n.; Ph 593.*
saururus *Lam. Fu & Ph 42; Ph & Hu 120.*
verticillatum *L. f. Gi 237, s.n.; Rayment s.n.*

SELAGINELLACEAE
P3 Selaginella
caffrorum *(Milde) Hieron. Gi 124; Ph 830.*
kraussiana *(Kunze) A. Br. ex Kuhn Bryant s.n.; Gi 807; Mgudlwa 29.*

OPHIOGLOSSACEAE
P6 Ophioglossum polyphyllum *A. Br. Gi 1502.*

GLEICHENIACEAE
P10 Gleichenia polypodioides *(L.) J.E. Sm. Gi s.n.; Ph 343.*

SCHIZAEACEAE
P12 Schizaea pectinata *(L.) Swartz Rayment s.n.*
P14 Mohria caffrorum *(L.) Desv. Fu & Ph 214; Gi 805, s.n.*

CYATHEACEAE
P19 Cyathea capensis *(L. f.) J.E. Sm. Gi 604, 779, s.n.*

HYMENOPHYLLACEAE
P20 Trichomanes pyxidiferum *L.* var. melanotrichum *(Schlechtd.) Schelpe GR 3828; Gi 774.*

DENNSTAEDTIACEAE
P23 Histiopteris incisa *(Thunb.) J. Sm. Ph 1505.*
P24 Pteridium aquilinum *(L.) Kuhn* subsp. aquilinum *Fu & Ph 223; GR 3484; Gi s.n.*
P26 Hypolepis sparsisora *(Schrad.) Kuhn Gi s.n.*

ADIANTACEAE/PTERIDACEAE
P32 Adiantum
capillus-veneris *L. Gi 590; Ph 877.*
poiretii *Wikstr.* var. poiretii *Gi 554, s.n.*
P33 Pteris
cretica *L. Gi 553, 798, 799, 1472.*
dentata *Forssk. GR 3810; Gi s.n.*
P34 Cheilanthes
bergiana *Schlechtd. Gi 552, s.n.; Ph 115.*
capensis *(Thunb.) Swartz*, Chumie Forest, *Young sub TRV 190* (PRE), Tor Doone, *Giffen 1278a* (PRE) (Anthony 1984: 102).
concolor *(Langsd. & Fisch.) R. & A. Tryon Gi 3.*
ecklonіana *(Kunze) Mett. Gi 796, 845; Ph 1040.*
hirta *Swartz GR 3042; Gi 1457, s.n.; Ph 832.*
multifida *(Swartz) Swartz* subsp. multifida *Gi 1463.*
quadripinnata *(Forssk.) Kuhn Gi 783, s.n.; Ph 1006.*
viridis *(Forssk.) Swartz* var. glauca *(Sim) Schelpe & N.C. Anthony Gi s.n.*
viridis *(Forssk.) Swartz* var. macrophylla *(Kuntze) Schelpe & N.C. Anthony Gi 791, 793, 794, s.n.; Ph 113.*
viridis *(Forssk.) Swartz* var. viridis *GR 3015; Gi s.n.*
P35 Pellaea calomelanos *(Swartz) Link Gi s.n.*

POLYPODIACEAE
P42 Polypodium
polypodioides *(L.) Hitchc.* subsp. ecklonii *(Kunze) Schelpe GR 3815, 3817; Gi 802, 803, s.n.*
vulgare *L. Gi 800, 801, 1341, s.n., Ph 824.*
P43 x Pleopodium simianum *Schelpe & N.C. Anthony Gi 511.*
P44 Pleopeltis
macrocarpa *(Bory ex Willd.) Kaulf. Gi s.n.*
schraderi *(Mett.) Tardieu Fu & Ph 43; Gi 61, s.n.*

ASPLENIACEAE
P52 Asplenium
aethiopicum *(Burm. f.) Becherer Gi 2, 787, 1462, s.n.*
boltonii *Hook. ex Schelpe GR 3829; Gi 786, s.n.*
erectum *Bory ex Willd.* var. erectum *GR 3820; Gi 551, 785, s.n.*
lunulatum *Swartz Gi 528, s.n.*
monanthes *L. Gi 784, s.n.*
platyneuron *(L.) Oakes Gi 1473, s.n.*
protensum *Schrad. Gi s.n.*
rutifolium *(Berg.) Kunze GR 3827; Gi s.n.*
stoloniferum *Bory GR 3826; Gi s.n.*

theciferum *(H.B.K.) Mett.* var. concinnum *(Schrad.) C. Chr. Gi 789.*
trichomanes *L. Ph 878.*
varians *Wall. ex Hook. & Grev.* subsp. fimbriatum *(Kunze) Schelpe Gi s.n.*
P53 Ceterach cordatum *(Thunb.) Desv. Gi 42.*

THELYPTERIDACEAE
P54 Thelypteris
bergiana *(Schlechtd.) Ching Gi 471, 555, s.n.; Ph 917.*
confluens *(Thunb.) Morton Ph 1284.*
pozoi *(Lagasca) Morton Gi 472, 775, s.n.*

ATHYRIACEAE
P61 Cystopteris fragilis *(L.) Bernh. Gi 138, s.n.*

LOMARIOPSIDACEAE
P62 Elaphoglossum acrostichoides *(Hook. & Grev.) Schelpe Gi 759, 804, s.n.; Ph 1270.*

ASPIDIACEAE/DRYOPTERIDACEAE
P66 Dryopteris inaequalis *(Schlechtd.) Kuntze Gi s.n.; Ph 939.*
P67 Cyrtomium caryotideum *(Wall. ex Hook. & Grev.) Presl* var. micropterum *(Kunze) C. Chr. Gi 777, 780, s.n.*
P68 Polystichum
luctuosum *(Kunze) T. Moore GR 3832; Gi 843, s.n.*
monticola *Schelpe & N.C. Anthony Fu & Ph 49; Gi s.n.*
pungens *(Kaulf.) Presl Gi 776, 1426a.*
transkeiense *Jacobsen*, Hogsback, *Jacobsen 4546* (Jacobsen 1978: 170).
P69 Arachnoides foliosa *(C. Chr.) Schelpe*, Hogsback, *Jacobsen 4544* (Jacobsen 1983: 450).
P70 Rumohra adiantiformis *(G. Forst.) Ching Gi s.n.*

BLECHNACEAE
P75 Blechnum
australe *L.* var. australe *Gi 781, 1464, s.n.; Ph 337.*
capense *(L.) Schlechtd. Ph 955.*
giganteum *(Kaulf.) Schlechtd. Gi 782, 1436, s.n.*
tabulare *(Thunb.) Kuhn Gi s.n.*

GYMNOSPERMAE

PODOCARPACEAE
13 Podocarpus
falcatus *(Thunb.) R. Br. ex Mirb. Fu s.n.; Fu & Ph 250; GR 3825, 3835; Gi 75.*
latifolius *(Thunb.) R. Br. ex Mirb. Gi 870; Ph 571.*

PINACEAE
22 Pinus spp. Seen naturalized in many places.

CUPRESSACEAE
38 Widdringtonia nodiflora *(L.) Powrie Gi 234.*

ANGIOSPERMAE — MONOCOTYLEDONEAE

POTAMOGETONACEAE
58 Potamogeton pusillus *L. Fu & Ph 197.*

POACEAE
K2 Coix lacryma-jobi *L. Ph 135.*
K10 Ischaemum fasciculatum *Brongn. Ph 1486.*
K28 Elionurus muticus *(Spreng.) Kunth Fu & Ph 100; GR 3414, 3453, 3490a; Ph & Hu 93.*
K29 Coelorhachis capensis *Stapf Ph 1323.*
K38 Miscanthus capensis *(Nees) Anderss.* var. capensis *Fu & Ph 299; Gi 660, s.n.*
K53 Eulalia villosa *(Thunb.) Nees Ph 1016.*
K71 Andropogon appendiculatus *Nees Br 42, 159; Fu* et al. *10, 11; GR 3477; Gi 1280; Ph & Hu 59.*
K72 Cymbopogon nardus *(L.) Rendle Fu & Ph 222, 300; GR 3133, 3540; Gi 1284, s.n.*
K73 Hyparrhenia hirta *Stapf Gi s.n.*
K78 Trachypogon spicatus *(L. f.) Kuntze Br 10, 15; Fu & Ph 249; Gi 1283.*
K80 Heteropogon contortus *(L.) Roem. & Schult. GR 3445; Ph 979.*
K83 Themeda triandra *Forssk. Br 18, 33; Fu & Ph 244; GR 3452.*
K89 Digitaria
diagonalis *(Nees) Stapf* var. diagonalis *Ph 1469.*
sanguinalis *(L.) Scop. Mahlobo 9.*
setifolia *Stapf Fu & Ph 212; GR 3492a.*
ternata *(A. Rich.) Stapf Gi s.n.*
K94 Alloteropsis semialata *(R. Br.) Hitchc.* subsp. eckloniana *(Nees) Gibbs Russell GR 3447; Ph 1193.*
K104 Brachiaria eruciformis *(J.E. Sm.) Griseb. Ph 1050.*
K107 Paspalum scrobiculatum *L. Gi s.n.*
K112 Echinochloa crus-galli *(L.) Beauv. Gi s.n.*
K115 Oplismenus hirtellus *(L.) Beauv. Gi 659, 1442, s.n.*
K116 Panicum
aequinerve *Nees Fu & Ph 225; GR 3416, 3489a; Gi s.n.*
deustum *Thunb. GR 3130; Gi 163, 512; Ph 105.*
ecklonii *Nees GR 3411, 3454; Ph 1155.*
hymeniochilum *Nees Ph 1324.*
K128 Setaria
sphacelata *(Schumach.) Moss* var. sericea *(Stapf) Clayton Ph 957.*
sphacelata *(Schumach.) Moss* var. sphacelata *Ph 1057.*
K132a Rhynchelytrum nerviglume *(Franch.) Chiov. Ph 964.*
K139 Pennisetum
clandestinum *Chiov. Ph 394.*
macrourum *Trin. Br 19; Fu 681; Fu & Ph 26, 177, 211.*
thunbergii *Kunth Br 01, 17, 24, 113; Fu & Ph 78, 80, 82, 121, 135, 147.*
K160 Ehrharta
calycina *J.E. Sm.* var. calycina *Fu & Ph 357.*
erecta *Lam.* var. erecta *Mdzeke 21; Ph 931.*
K163 Phalaris
angusta *Nees ex Trin. Ph 506.*
arundinacea *L. Fu & Ph 170.*
K164 Anthoxanthum
ecklonii *(Nees ex Trin.) Stapf Dyer 339* (GRA); *Rattray 204* (GRA).
odoratum *L. Ph 906.*
K173 Arundinella nepalensis *Trin. Br 40; Fu 756; Fu* et al. *44; Gi s.n.; Ph 1058.*
K174 Tristachya leucothrix *Nees Br 34, 43; Fu* et al. *12; Fu & Ph 330; GR 3409; Ph & Hu 62.*
K192 Holcus lanatus *L. Fu & Ph 178.*
K197 Helictrotrichon hirtulum *(Steud.) Schweick. GR 3518; Ph 1028.*
K204c Merxmuellera drakensbergensis *(Schweick.) Conert Ph & Hu 1.*
K205 Pentaschistis
setifolia *(Thunb.) McClean Br 16; Fu & Ph 213.*
tysonii *Stapf Fu & Ph 97; GR 3507a.*
sp. *Fu & Ph 358.*
K214 Phragmites australis *(Cav.) Steud. Fu 759; Fu & Ph 175.*
K243 Agrostis
barbuligera *Stapf* var. barbuligera *Br 09; Fu 724; GR 3418.*
bergiana *Trin.* var. bergiana *Mdzeke 17.*
K262 Aristida junciformis *Trin. & Rupr.* subsp. galpinii *(Stapf) De Winter Br 20, 38, 157; Fu* et al. *48; Gi s.n.; Mdzeke 06.*
K263 Stipa
dregeana *Steud.* var. elongata *(Nees) Stapf Ph 797.*
trichotoma *Nees Fu & Ph 317.*
K283 Sporobolus centrifugus *(Trin.) Nees GR 3487a; Gi 1282; Ph & Hu 87.*
K286 Eragrostis
caesia *Stapf Gi s.n.*
capensis *(Thunb.) Trin. Br 134; Fu* et al. *45; GR 3446; Ph 978; Ph & Hu 60.*

curvula *(Schrad.) Nees GR 3444; Ph 1487.*
planiculmis *Nees Fu 752.*
racemosa *(Thunb.) Steud. Ph & Hu 96; Ph 1257.*
K294 Microchloa caffra *Nees Gi s.n.*
K296 Cynodon dactylon *(L.) Pers. Fu & Ph 281; Gi s.n.*
K298 Harpochloa falx *(L. f.) Kuntze Br 158; Fu & Ph 58; GR 3438; Gi 1279a; Ph & Hu 67.*
K371 Fingerhuthia sesleriiformis *Nees Br 12; Fu 722; Fu* et al. *07; Fu & Ph 81, 96.*
K374 Koeleria capensis *(Steud.) Nees Fu & Ph 99; GR 3412; Ph & Hu 86.*
K386 Melica racemosa *Thunb. GR 3519.*
K399 Lasiochloa longifolia *(Schrad.) Kunth Ph 1135; Ph & Hu 162.*
K400 Stiburus alopecuroides *(Hack.) Stapf Br 77.*
K404 Briza
maxima *L. Ph 1525.*
minor *L. Ph 507.*
K407 Poa
annua *L. Mdzeke 20.*
binata *Nees Ph 1347.*
heterogama *Hack. Ph 1169.*
pratensis *L. Fu & Ph 328.*
K417 Festuca
caprina *Nees* var. caprina *Br 118, 153; Fu & Ph 98.*
caprina *Nees* var. irrasa *Stapf GR 3408.*
costata *Nees* var. costata *Br 123; Ph & Hu 89.*
longipes *Stapf Ph 791.*
K418 Vulpia
bromoides *(L.) S.F. Gray Fu* et al. *39.*
myuros *(L.) C.C. Gmel. Fu & Ph 321.*
K428 Bromus
molliformis *Lloyd Fu & Ph 320.*
speciosus *Nees Fu & Ph 132; GR 3413, 3494a; Ph & Hu 92.*
unioloides *H.B.K. Mdzeke 28.*
K432 Brachypodium flexum *Nees GR 3024; Gi s.n.; Russell 2354.*
K433 Lolium multiflorum *Lam. Fu & Ph 343.*
K457 Thamnocalamus tesselata *(Nees) Soderstrom & Ellis Gi 280; Ph 434.*

CYPERACEAE
454 Ascolepis capensis *(Kunth) Ridley Br 109, 135, 147; Fu 735; Fu* et al. *53; Fu & Ph 173, 332.*
456 Carpha
bracteosa *C.B. Cl. Fu & Ph 182, 347.*
glomerata *(Thunb.) Nees Ph 935.*
459 Cyperus
albostriatus *Schrad. GR 3023; Gi 1589.*
difformis *L. Ph 572.*
obtusiflorus *Vahl* var. flavissimus *Boeck. Ph 99, 1298.*
pulcher *Thunb. Ph 110, 950.*
schlechteri *C.B. Cl. Ph 1165.*
semitrifidus *Schrad. Ph 1005, 1164; Ph & Hu 165.*
tenellus *L.* var. tenellus *Gi 1596; Ph 344.*
459a Pycreus
betschuanus *(Boeck.) C.B. Cl. Fu & Ph 122, 157, 200.*
cooperi *C.B. Cl. Br 25, 140; Fu* et al. *14; Fu & Ph 123, 156, 169, 179, 205.*
macranthus *C.B. Cl. Fu & Ph 158, 207.*
mundtii *Nees Fu & Ph 163, 187.*
nitidus *(Lam.) J. Raynal Fu & Ph 102, 164, 171; Ph 237, 238.*
oakfortensis *C.B. Cl. Fu & Ph 28.*
unioloides *(R. Br.) Urb. Fu* et al. *06, 51.*
459c Mariscus
congestus *(Vahl) C.B. Cl. GR 3007; Gi 1593; Ph 156, 239, 1035.*
grantii *C.B. Cl. Ph 1254.*
owanii *(Boeck.) C.B. Cl. Ph 398.*
tabularis *(Schrad.) C.B. Cl. Ph 1299.*
thunbergii *(Vahl) Schrad. Fu & Ph 192.*
462 Kyllinga
elatior *Kunth Ph 109.*
erecta *Schumach. Fu & Ph 186.*
melanosperma *Nees Ph 1296.*
pauciflora *Ridley Br 26, 136, 168; Fu & Ph 159; Ph 242.*
pulchella *Kunth Ph 1188.*
465 Ficinia
bergiana *Kunth Ph 921.*
cinnamomea *C.B. Cl. Gi 3509a; Ph 944.*
fascicularis *Nees Gi 1597, s.n.; Ph 426.*
stolonifera *Boeck. Ph & Hu 76.*
tristachya *(Rottb.) Nees GR 3469.*
467 Fuirena
pubescens *(Poir.) Kunth Fu* et al. *54; Fu & Ph 208; GR 3510a.*
sp. *Ph 1498.*
468 Scirpus
falsus *C.B. Cl. Ph & Hu 17.*
ficinioides *Kunth Br 02, 30, 87, 101, 103; Fu* et al. *29; Fu & Ph 79, 335.*
inanis *(Thunb.) Steud. Fu & Ph 125.*
468a Schoenoplectus paludicola *(Kunth) Palla ex J. Raynal Ph 1328.*
468b Isolepis
cernua *(Vahl) Roem. & Schult. Fu 692; Fu* et al. *40; Fu & Ph 77, 189.*
costata *(Boeck.) A. Rich. Br 167; Fu 693, 719; Fu* et al. *03, 41, 42; Fu & Ph 124; GR 3003.*
fluitans *(L.) R. Br. Fu & Ph 01, 134; Ph 1225.*
ludwigii *Kunth Fu & Ph 162.*
natans *(Thunb.) Dietr. Fu & Ph 29, 131, 201, 209.*
sepulcralis *Steud. GR 3513a; Ph 493.*
469 Eleocharis acutangula *(Roxb.) Schult. Fu & Ph 193.*
471 Fimbristylis complanata *(Retz.) Link Ph 236, 1203.*
471a Bulbostylis
humilis *(Kunth) C.B. Cl. Fu & Ph 7; Ph 1350.*
schoenoides *(Kunth) C.B. Cl. Fu & Ph 83, 103, 333.*
471b Abildgaardia ovata *(Burm. f.) Kral Ph 1310.*
492 Rhynchospora brownii *Roem. & Schult. Fu 728, 733; Fu* et al. *5; Fu & Ph 14, 160.*
494 Tetraria
cuspidata *(Rottb.) C.B. Cl. Fu & Ph 118, 248; GR 3514a; Ph 562.*
macowaniana *B.L. Burtt Fu & Ph 234; Ph 557.*
521 Schoenoxiphium
lehmannii *(Nees) Steud. Gi 513, 1588; Ph 930.*
perdensum *Kukkonen*, Keiskammahoek, near Ghulu Kop, 4,000 ft *Dyer 245a* (K) (Kukkonen 1983: 822).
rufum *Nees Ph & Hu 112; Robinson s.n.*
sparteum *(Wahlenb.) C.B. Cl. Ph & Hu 16, 83, 166.*
sp. aff. S. schweickerdtii *Merxm. & Podlech Ph 430; Ph & Hu 18.*
525 Carex
acutiformis *Ehrh. Br 98; Fu 688, 745, 746; Fu* et al. *52; Fu & Ph 86.*
clavata *Thunb. Fu & Ph 128, 172; Gi 1586.*
petitiana *A. Rich. Ph 940.*
schlechteri *Nelmes Ph 788.*
zuluensis *C.B. Cl. Ph 1170.*

ARACEAE
748 Zantedeschia
aethiopica *(L.) Spreng. GR 3500; Gi 885.*
albomaculata *(Hook.) Baill.* subsp. albomaculata *Ph 1098.*

RESTIONACEAE
804 Restio sejunctus *Mast. Ph 323.*
804c Ischyrolepis distracta *(Mast.) Linder*, Gaika's Kop (Linder 1985: 404).
804j Calopsis paniculata *(Rottb.) Desv. Gi 1017; Ph 411.*
804p Hydrophilus rattrayi *(Pillans) Linder*, Hogsback (Linder 1985: 484).
807 Elegia asperiflora *(Nees) Kunth* var. lacerata *(Pillans) Pillans Fu & Ph 16, 176; Gi s.n.*

XYRIDACEAE
826 Xyris capensis *Thunb.* *Fu 734; Fu* et al. *02; Fu & Ph 30; Gi 273.*

ERIOCAULACEAE
828 Eriocaulon dregei *Hochst.* var. dregei *Br 29, 137; Fu 736; Fu* et al. *09; Fu & Ph 4; Ph 241.*

COMMELINACEAE
896 Commelina
africana *L.* var. africana *Br 21; Ph 142.*
africana *L.* var. krebsiana *(Kunth) C.B. Cl.* *Gi s.n.*

JUNCACEAE
936 Juncus
bufonius *L.* *Fu & Ph 202; Ph 499.*
capensis *Thunb.* *GR 3511a.*
dregeanus *Kunth* *Br 110, 126; Fu & Ph 3, 85, 101, 188; GR 3512a; Ph 494.*
effusus *L.* *Fu 714, 743, 744; Fu* et al. *30; Fu & Ph 130, 190; Ph 812.*
exsertus *Buchen.* *Fu & Ph 191.*
lomatophyllus *Spreng.* *Br 139; Fu 682, 723; Fu & Ph 08; GR 3002.*
oxycarpus *Kunth* *Fu* et al. *49; Fu & Ph 27, 129; GR 3504a; Ph 496.*
punctorius *L. f.* *Fu & Ph 165.*

LILIACEAE
969 Androcymbium longipes *Bak.* *Gi 640; Ph 1348.*
972 Wurmbea elatior *B. Nord.* *Br 13; Ph 1074.*
985 Bulbine
abyssinica *A. Rich.* *Ph 1290.*
lagopus *(Thunb.) N.E. Br.* *Ph 884, 1333.*
985a Trachyandra saltii *(Bak.) Oberm.* var. saltii *GR 3441; Ph & Hu 51.*
989 Anthericum angulicaule *Bak.* *Ph 1332.*
990 Chlorophytum
bowkeri *Bak.* *Ph 1191.*
comosum *(Thunb.) Jacq.* *Gi 620, 720, 1542.*
1002 Caesia contorta *(L. f.) Dur. & Schinz* *GR 3471; Ph 770.*
1011 Bowiea volubilis *Harv. ex Hook. f.* *Ph & Hu 100.*
1012 Eriospermum natalense *Bak.* *Gi 1106; Ph & Hu 98.*
1024 Kniphofia
baurii *Bak.* *Ph 1104.*
linearifolia *Bak.* *Ph 1319.*
northiae *Bak.* *Gi 564.*
parviflora *Kunth* *Ph 1277.*
triangularis *Kunth* subsp. triangularis *Fu & Ph 199; Gi 1352.*
uvaria *(L.) Hook.* *Ph 1078.*
1026 Aloe
arborescens *Mill.* *Ph 833.*
aristata *Haw.* *Ph 1138.*
ecklonis *Salm-Dyck* *Gi 1322.*
ferox *Mill.* Seen at lower altitudes near Mitchell's Pass.
maculata *All.* *Fu & Ph 313.*
1046 Agapanthus
campanulatus *Leighton* subsp. campanulatus *Ph 1266.*
praecox *Willd.* subsp. orientalis *(Leighton) Leighton* *GR 3507; Gi 1247.*
1047 Tulbaghia acutiloba *Harv.* *Gi s.n.; Ph & Hu 101.*
1072 Lilium formosanum *(Bak.) Wallace* *Ph 1044.*
1079 Albuca
caudata *Jacq.* *Gi 210; Ph & Hu 69.*
fastigiata *(L. f.) Dryand.* *Ph 1182.*
nelsonii *N.E. Br.* *Ph & Hu 66.*
setosa *Jacq.* *GR 3461; Ph 1139.*
1080 Urginea tenella *Bak.* *Ph & Hu 55.*
1082 Drimia elata *Jacq.* *Gi 1650.*
1086 Scilla nervosa *(Burch.) Jessop* *Fu & Ph 139.*
1088 Eucomis
autumnalis *(Mill.) Chitt.* subsp. autumnalis *GR 3491a.*
comosa *(Houtt.) Wehrh.* var. comosa *Fu & Ph 166; Gi 454.*
1089 Ornithogalum
conicum *Jacq.* subsp. conicum *Ph 941.*
graminifolium *Thunb.* *Ph & Hu 40.*
juncifolium *Jacq.* *Fu & Ph 117; Gi 281, 1165; Ph 943; Ph & Hu 39.*
longibracteatum *Jacq.* *Ph 887.*
paludosum *Bak.*, Elandsberg, *Cooper 219* (K) (Obermeyer 1978: 350).
tenuifolium *Delaroche* subsp. tenuifolium *Fu* et al. *16; Fu & Ph 340; GR 3467; Gi 1165a.*
1090a Ledebouria floribunda *(Bak.) Jessop* *Ph 968; Ph & Hu 1079.*
1101 Massonia echinata *L. f.* *Fu 680.*
1113 Protasparagus
aethiopicus *(L.) Oberm.* *Fu & Ph 263; Gi 849; Ph 884.*
africanus *(Lam.) Oberm.* *Ph 1136.*
densiflorus *(Kunth) Oberm.* *Ph 1102; Ph & Hu 64.*
denudatus *(Kunth) Oberm.* *Gi s.n.*
laricinus *(Burch.) Oberm.* *Ph 1103; Tu 138.*
macowanii *(Bak.) Oberm.* *Ph 1106.*
subulatus *(Thunb.) Oberm.* *Gi 848.*
virgatus *(Bak.) Oberm.* *Gi 453.*
1113a Myrsiphyllum
asparagoides *(L.) Willd.* *Fu & Ph 45; Gi 621, g799, 1115; Robinson 1065.*
ramosissimum *(Bak.) Oberm.* *Nete 21; Ph & Hu 5; Tyibilika 44.*
1147 Behnia reticulata *(Thunb.) Didr.* *Gi 494, 530, 645.*

AMARYLLIDACEAE
1167 Haemanthus albiflos *Jacq.*, Menziesberg, *Acocks 1114* (K, PRE); Hogsback Forest Reserve, *Dahlstrand 2935* (GRA, STE) (Snijman 1984: 63).
1167a Scadoxus puniceus *(L.) Friis & Nordal* *Ph 945.*
1175 Nerine undulata *(L.) Herb.* *GR 3027a; Gi 449, 1523; McGillivray 48; Ph 559, 1486.*
1191 Cyrtanthus
breviflorus *Harv.*, Umgaika Kop, *Cooper 255* (Reid & Dyer 1984: 14).
huttonii *Bak.* *Gi s.n.; Ph 1113.*
tuckii *Bak.* var. viridilobus *Verdoorn* *Ph 948.*

HYPOXIDACEAE
1230 Hypoxis
angustifolia *Lam.* *Fu & Ph 342.*
costata *Bak.* *GR 3456.*
filiformis *Bak.* *Br 107; Fu* et al. *47; Fu & Ph 12, 95.*
flanaganii *Bak.* *Ph 1011.*
hemerocallidea *Fisch. & Mey.* *GR 3482.*
multiceps *Buchinger* *Ph & Hu 91.*
rigidula *Bak.* var. rigidula *Ph & Hu 80.*
setosa *Bak.* *Fu & Ph 344.*
woodii *Bak.* *Ph 1194, 1496.*
sp. *Br 161; Fu & Ph 322; GR 3483; Ph 993.*

DIOSCOREACEAE
1252 Dioscorea
retusa *Mast.* *Ph 1192, 1316.*
rupicola *Kunth* *Gi 995, 1105.*
stipulosa *Uline ex Kunth* *Gi 1195, 1300; Ph 1227.*
sylvatica *(Kunth) Eckl.*, Hogsback Pass, *Archibald 7556* (GRA) (Archibald 1967: 36).

IRIDACEAE
1260 Syringodea concolor *(Bak.) De Vos* *Gi s.n.*
1261 Romulea
atrandra *G.J. Lewis* var. lewisiae *De Vos* *Ph 879.*
autumnalis *L. Bol.*, Summit of Hog's Back, *Scully 346* (SAM) (De Vos 1972: 205).
macowanii *Bak.* var. macowanii *Ph 826.*
1265 Moraea
elliottii *Bak.* *Fu & Ph 120.*
huttonii *(Bak.) Oberm.* *Gi 196; Makunga M31; Ph 400.*

muddii *N.E. Br. Ph 1268.*
reticulata *Goldbl. GR 3019; Gi s.n., 443; Ph 1054.*
stricta *Bak. Ph & Hu 36.*
1265a Dietes iridoides *(L.) Sweet ex Klatt Ph 954.*
1295 Aristea
anceps *Eckl. ex Klatt Ph & Hu 73.*
cognata *N.E. Br. ex Weim. Fu & Ph 91; Ph & Hu 72.*
ecklonii *Bak. Makunga M42.*
montana *Bak. Ph 1273.*
schizolaena *Harv. Fu & Ph 233; Gi 477, g1262; Ph & Hu 71.*
1299 Schizostylis coccinea *Backh. & Harv. Fu 684; GR 3136; Gi 165; Makunga M81.*
1301 Hesperantha
huttonii *(Bak.) Hilliard & Burtt Gi s.n. Ph 163.*
longituba *(Klatt) Bak. Gi s.n., Fu & Ph 38.*
pulchra *Bak. Ph 561.*
sp. *Br 88b.*
1302 Ixia orientalis *L. Bol. Br 106, 149, 152; Fu & Ph 88; Makunga M70.*
1303 Dierama
igneum *Klatt Fu & Ph 133; Ph 987.*
pendulum *(L. f.) Bak. Gi 726a; Ph 1343.*
pulcherrimum *(Hook f.) Bak. GR 3018.*
1306 Tritonia
disticha *(Klatt) Bak.* subsp. rubrolucens *(R.C. Fost.) De Vos Makunga M64; Ph & Hu 25.*
lineata *(Salisb.) Ker-Gawl.* var. lineata *Ph 387.*
1311 Gladiolus
dalenii *Van Geel Ph 1229.*
ecklonii *Lehm.* subsp. ecklonii *Makunga M42.*
longicollis *Bak.* var. longicollis *Br 108; Ph & Hu 2.*
ochroleucus *Bak.* var. macowanii *(Bak.) Oberm. Page & Tapson 20.*
ochroleucus *Bak.* var. ochroleucus *Ph 1219.*
1315 Watsonia
longifolia *J.W. Mathews & L. Bol. GR 3545; Gi 118, 726; Makunga M13; Ph & Hu 157, 158.*
pillansii *L. Bol. Gi 490.*
sp. *Fu & Ph 181; Ph & Hu 21, 58.*
1316a Anomatheca laxa *(Thunb.) Goldbl. Gi 142, s.n.; Ph 106.*

ORCHIDACEAE
1407 Stenoglottis fimbriata *Lindl. Gi s.n.*
1408 Holothrix
orthoceras *(Harv.) Reichb. f. Gi 1536, s.n.*
scopularia *(Lindl.) Reichb. f. Fu & Ph 110; Gi 215.*
1414 Huttonaea pulchra *Harv. Gi 604, 613, s.n.*
1422 Habenaria
falcicornis *(Burch. ex Lindl.) H. Bol.* var. caffra *(Schltr.) Renz & Schelpe Gi 605; Ph 1306.*
laevigata *Lindl.* subsp. laevigata *Gi 607.*
malacophylla *Reichb. f. Gi 1538.*
1422b Bonatea cassidea *Sond. Gi 86; Ph 904.*
1429 Neobolusia tysonii *(H. Bol.) Schltr. Ph 1291.*
1430 Satyrium
bracteatum *(L. f.) Thunb.*, Gaika's Kop, *Rattray s.n.* (BOL) (Hall 1982: 122).
cristatum *Sond.* var. cristatum, Hogsback Mtn, *Rattray s.n.* (BOL) (Hall 1982: 94).
hallackii *H. Bol* subsp. ocellatum *(H. Bol.) A.V. Hall*, Hogsback Mtn, *Rattray 15780* (BOL, PRE), *Rattray 86* (GRA) (Hall 1982: 57).
ligulatum *Lindl.*, Hogsback, *Barker 1488* (NBG) (Hall 1982: 46).
longicauda *Lindl.* var. jacottetianum *(Kraenzl.) A.V. Hall Gi 216, 617, 1315.*
longicauda *Lindl.* var. longicauda *Ph 612, 618, 1167.*
parviflorum *Swartz Gi 108; Ph 1267.*
1431 Schizochilus zeyheri *Sond. Gi 217, 603; Ph 1282.*
1433 Brownleea
coerulea *Harv. ex Lindl. Gi 444, 602; Ph 1317.*
macroceras *Sond. Ph 1265.*
parviflora *Harv. ex Lindl. Gi 158.*
recurvata *Sond. Gi 608.*
1434 Disa
aconitoides *Sond.* subsp. aconitoides *Gi 1314.*
chrysostachya *Swartz Gi 214.*
crassicornis *Lindl. GR 3005; Gi 109.*
pulchra *Sond. Ph & Hu 56* (KEI).
sagittalis *(L. f.) Swartz GR 3473; Gi 1162; Ph & Hu 44, 122; Robinson s.n.*
sanguinea *Sond.*, Amatole Mts (Linder 1981a: 70).
scullyi *H. Bol.*, Menziesberg, *Scully s.n.* (BM, BOL, K); Hogsback, *Batten s.n.* (BOL) (Linder 1981a: 119).
stricta *Sond. Gi 614.*
thodei *Schltr. ex Kraenzl.*, Gaika's Kop (Linder 1981a: 115).
tysonii *H. Bol.*, Quarter degree square 3227CA, land over 1500 m (from distribution map, Linder 1981a: 74).
versicolor *Reichb. f. Gi 245, 1319.*
1435 Herschelia venusta *(H. Bol.) Kraenzl.*, Hogsback Mtn, *Rattray* s.n. (BOL) (Linder 1981b: 378).
1436 Monadenia brevicornis *Lindl. Gi 606.*
1437 Disperis
lindleyana *Reichb. f. Gi 609.*
macowanii *H. Bol. Ph 1345.*
micrantha *Lindl. Gi s.n.*
stenoplectron *Reichb. f. Gi s.n.*
wealii *Reichb. f. Gi 1317.*
1440 Corycium
dracomontanum *Parkman & Schelpe Gi 1163; Ph & Hu 163.*
magnum *(Reichb. f.) Rolfe Gi 615.*
1565 Polystachya
ottoniana *Reichb. f. GR 3834; Gi 19, 556, 610.*
pubescens *Reichb. f. Gi 889.*
1648 Eulophia
aculeata *(L. f.) Spreng.* subsp. aculeata *GR 3474; Ph & Hu 131.*
aculeata *(L. f.) Spreng.* subsp. huttonii *(Rolfe) A.V. Hall Gi 1164, 1166, 1246; Ph & Hu 164.*
foliosa *(Lindl.) H. Bol.*, Chumie Peak, *Scully 172* (BOL) (Hall 1965: 228).
macowanii *Rolfe*, Chumie Peak, *Scully 173* (BOL) (Hall 1965: 232).
meleagris *Reichb. f. Ph & Hu 132.*
ovalis *Lindl.* subsp. ovalis *Ph & Hu 65.*
1828 Angraecum
conchiferum *Lindl. Gi 770.*
sacciferum *Lindl. Gi 601.*
1837 Mystacidium
flanaganii *(H. Bol.) H. Bol. Ph 114.*
gracile *(Reichb. f.) Harv. Gi 20, 611.*

ANGIOSPERMAE — DICOTYLEDONEAE

PIPERACEAE
1866 Peperomia
retusa *(L. f.) A. Dietr. Ph 1114.*
tetraphylla *(G. Forst.) Hook. & Arn. GR 3824; Gi 44, 893.*

SALICACEAE
1873 Salix
capensis *Thunb.* subsp. capensis *Gi 249.*
sp. *Tu 118.*

MYRICACEAE
1874 Myrica
brevifolia *E. Mey. ex DC. Fu & Ph 235; Gi 194; Ph 425.*
serrata *Lam.*, Hogsback, *Rattray 303* (PRE) (Killick 1969: 9).

BETULACEAE
1887 Betula sp. *GR 3813, 3814.*

FAGACEAE
1893 Quercus robur *L. Robinson 1058.*

ULMACEAE
1898 Celtis africana *Burm. f. Tu 183.*
1906 Chaetacme aristata *Planch. Ph 786.*

MORACEAE
1961 Ficus
burtt-davyi *Hutch. Fu & Ph 312.*
sur *Forssk. Fu s.n.; Gi s.n.*

URTICACEAE
1980 Laportea peduncularis *(Wedd.) Chew Gi 112, 400, 560, 869, 1019.*
2007 Parietaria micrantha *Ledeb. Ph 1340.*
2013 Droguetia iners *Forssk.* subsp. iners *Gi 1458, 1537.*
2014a Didymodoxa caffra *(Thunb.) Friis & Wilmot-Dear Gi 868, 1545.*

PROTEACEAE
2035 Protea
simplex *Phill. Gi 1160; Lyle 79.*
subvestita *N.E. Br. Gi 1353; Ph 567; Tu 250.*

LORANTHACEAE
2074a Tapinanthus prunifolius *(E. Mey. ex Harv.) V. Tieghem Gi 1065.*

VISCACEAE
2093 Viscum obscurum *Thunb. Fu & Ph 255.*

SANTALACEAE
2104 Colpoon compressum *Berg. Gi s.n.*
2116 Osyridocarpus schimperianus *(Hochst. ex A. Rich.) DC. Gi 478.*
2118 Thesium
pallidum *DC. Gi 230, 1261.*
triflorum *Thunb. ex L. f. Gi 581.*

POLYGONACEAE
2195 Rumex
angiocarpus *Murb. Br 86; Fu 747; Gi 1226, 1276.*
crispus *L. Ph 1287.*
dregeanus *Meisn.* var. dregeanus *Ph 1166.*
lanceolatus *Thunb. Ph 1187.*
sagittatus *Thunb. Gi 498; McGillivray 5; Ph 1036.*
steudelii *Hochst. Ph 1223, 1289.*
woodii *N.E. Br. Fu & Ph 136, 316.*
2201 Polygonum
lapathifolium *L.* var. maculatum *(S.F. Gray) T.-Dyer & Trin. Ph 1025.*
meisnerianum *Cham. & Schlechtd. Fu & Ph 196; Gi s.n.*
persicaria *L. GR 3000.*
salicifolium *Willd. Ph 1315.*

CHENOPODIACEAE
2223 Chenopodium multifidum *L. Ph 1046.*

AMARANTHACEAE
2312 Cyathula uncinulata *(Schrad.) Schinz Gi 863; Ph 1471.*
2328 Achyranthes sicula *(L.) All. Gi 544, 864.*

AIZOACEAE
2379 Psammotropha mucronata *(Thunb.) Fenzl* var. mucronata *Br 156; Gi 406, 1227.*

PHYTOLACCACEAE
2380 Phytolacca
heptandra *Retz. Ph 1301.*
octandra *L. Ph 264.*

MESEMBRYANTHEMACEAE
2405 Aptenia cordifolia *(L. f.) Schwant. Gi 1056.*

CARYOPHYLLACEAE
2429 Stellaria media *(L.) Vill. Ph 887.*
2430 Cerastium
capense *Sond. Br 100, 104, 145; Fu & Ph 331; Ph 926.*
indicum *Wight & Arn. Ph 1482.*
2490 Silene
burchellii *Otth* var. burchellii *Br 127; Ph 1281.*
undulata *Ait. Gi 1081.*
vulgaris *(Moench) Garcke* subsp. macrocarpa *(Marsden) Jones & Turrill Ph 1131.*
2502 Dianthus
basuticus *Burtt Davy* subsp. basuticus var. basuticus *Ph & Hu 168.*
crenatus *Thunb. Ph & Hu 150.*

RANUNCULACEAE
2541 Anemone caffra *Eckl. & Zeyh. Ph 1067; Ph & Hu 138.*
2541a Knowltonia cordata *H. Rasm. Ph 913.*
2542 Clematis brachiata *Thunb. Gi 1250; Mgudlwa 40; Ph 551; Tu 193.*
2546 Ranunculus
baurii *Macowan Ph 432.*
meyeri *Harv. Fu & Ph 2, 50, 334; Gi s.n.*
multifidus *Forssk. Br 102; Fu & Ph 75; GR 3497; Gi 441, 592, 593; Ph 423.*
2548 Thalictrum rhynchocarpum *Dill. & Rich. Gi 467.*

MENISPERMACEAE
2574 Cissampelos torulosa *E. Mey. ex Harv. Fu & Ph 256; Gi 1504; Ph 112.*

TRIMENIACEAE
2759a Xymalos monospora *(Harv.) Baill. Gi 73, g852 s.n.; Ph 869, 870.*

LAURACEAE
2813 Cryptocarya woodii *Engl. Gi 99.*

PAPAVERACEAE
2853 Papaver aculeatum *Thunb. Fu & Ph 87, 141.*

FUMARIACEAE
2858a Phacocapnos pruinosus *(E. Mey.) Bernh. Ph & Hu 167.*
2861 Fumaria muralis *Sond. ex Koch* subsp. muralis *Ph 1526.*

BRASSICACEAE
2875 Heliophila
elongata *(Thunb.) DC. Gi 284, 1245, s.n.; Ph 1097; Ph & Hu 34.*
rigidiuscula *Sond. Fu & Ph 108, 356; Gi 1117.*
2883 Lepidium ecklonii *Schrad.*, Hogsback, *Jacot Guillarmod 4523* (Marais 1970: 93).
2965 Rorippa nasturtium-aquaticum *(L.) Hayek GR 3823.*
2966 Cardamine africana *L. Ph 903.*

CAPPARACEAE
3112 Maerua racemulosa *(A. DC.) Gilg & Ben. Gi 534.*

DROSERACEAE
3136 Drosera aliciae *R. Hamet Fu & Ph 18; Gi 244, 272, 557; Ph & Hu 123.*

CRASSULACEAE
3164 Cotyledon orbiculata *L.* var. oblonga *(Haw.) DC. Ph 897.*
3168 Crassula
cordata *Thunb. Gi 476.*
dependens *H. Bol. Fu 697; Fu & Ph 31.*
natans *Thunb.* var. natans *Fu & Ph 204; Ph 1141.*
nemorosa *(Eckl. & Zeyh.) Walp. Gi 1029a; Ph 907.*
nudicaulis *L.* var. nudicaulis *Br 90; Gi 1332.*
obovata *Haw.* var. obovata *Gi 349.*
orbicularis *L. Ph 884.*

pellucida *L.* subsp. marginalis *(Dryand. in Ait.) Tölken Br 82; Gi 350, 1340; Russell 2351.*
sarcocaulis *Eckl. & Zeyh.* subsp. sarcocaulis *Gi 1577a, s.n.*
sediflora *(Eckl. & Zeyh.) Endl. ex Walp.* var. amatolica *(Schonl.) Tölken*, Cata Ridge, *Dyer 356* (GRA, K, LU, PRE) (Tölken 1977: 374).
spathulata *Thunb. Gi 1018, 1540.*
vaginata *Eckl. & Zeyh. Ph 1065.*
vaillantii *(Willd.) Roth. Ph 1483; Ph & Hu 145.*
sp. *Ph 564; Ph & Hu 53.*

ESCALLONIACEAE
3241 Choristylis rhamnoides *Harv. Gi 320, 1444, s.n.*

PITTOSPORACEAE
3252 Pittosporum viridiflorum *Sims Gi 98, s.n.; Ph 759; Tu 235.*

HAMAMELIDACEAE
3311 Trichocladus ellipticus *Eckl. & Zeyh. ex Walp. Fu s.n.; Gi 97, 890, s.n.; Ph 778, 1122.*

ROSACEAE
3353 Rubus
fruticosus *L. Gi 1348, 1351; Tu 91.*
immixtus *C.E. Gust. Fu & Ph 217; GR 3489; Gi 111, 1152; Tu 106.*
ludwigii *Eckl. & Zeyh.* subsp. ludwigii, Hogsback, *Rattray s.n.* (PRE) (Stirton 1984: 103).
phoenicolasius *Maxim. Ph 937.*
pinnatus *Willd. Gi 275; Ph 938.*
rigidus *Sm. Gi 185, 343; Ph 936.*
3355 Duchesnea indica *(Andr.) Focke GR 3026; Mahlobo 24; Mgudlwa 23.*
3365 Geum capense *Thunb. Gi 341; Ph 390.*
3375 Alchemilla
capensis *Thunb. Ph 512.*
elongata *Eckl. & Zeyh. Fu & Ph 168.*
hirsuto-petiolata *(De Wild.) Rothm. Gi 762; Ph & Hu 135.*
sp. 1 *Ph & Hu 28.*
sp. 2 *Fu 696, 755; Gi 1271; Ph 1320.*
3376 Agrimonia procera *Wallr. Br 176; Gi 402, 1026; Ph 1489.*
3379 Leucosidea sericea *Eckl. & Zeyh. Gi 538; Ph 410, 428; Robinson 1001, 1064; Tu 207, 215.*
3388 Cliffortia
linearifolia *Eckl. & Zeyh. Fu & Ph 305; Tu 92, 94, 95, 102, 103, 119, 126, 194, 221.*
paucistaminea *Weim. Fu & Ph 215, 242; GR 3493a; Gi 342; Tu 222, 229, 240, 244.*
serpyllifolia *Cham. & Schlechtd. Ph 508; Tu 214.*
strobilifera *Murray Tu 254.*
sp. (C. eriocephalina *Cham.* sensu Story 1952: 152) *Story 3318* (GRA).
3389 Rosa odorata *Sweet Ph 916, 1043.*
3396 Prunus
africana *(Hook. f.) Kalkm. Tu 197.*
spp. Introduced species have become naturalized, mainly along roads.

FABACEAE
3446 Acacia
karroo *Hayne Tu 269.*
mearnsii *De Wild. Ph 899.*
melanoxylon *R. Br. Ph 892.*
3468 Entada spicata *(E. Mey.) Druce Fu s.n.; Gi 1058; Tu 190.*
3506 Schotia latifolia *Jacq. Fu s.n.; Fu & Ph 267; Gi 532, 1157.*
3536 Cassia capensis *Thunb.* var. capensis *Gi 1061, 1149; Ph 95.*
3607 Calpurnia
aurea *(Ait.) Benth.* subsp. sylvatica *(Burch.) Brummitt Fu s.n.; Gi 527, g889; Tu 192.*
floribunda *Harv. Gi 161, 1454.*
3608 Virgilia divaricata *Adamson Tu 246.*
3657 Lotononis
carnosa *Benth. Gi 1172; Ph 959, 1094, 1230; Ph & Hu 141.*
cytisoides *Bak.* var. cytisoides *Br 180; Fu & Ph 60; GR 3516.*
sp. *Ph 1218, 1300.*
3662 Aspalathus
frankenioides *DC. Fu & Ph 238; Ph 1280.*
simii *H. Bol.* subsp. katbergensis *R. Dahlg. Ph 969.*
3663 Buchenroedera
holosericea *Benth. GR 3538; Ph 793, 996, 1221; Ph & Hu 14.*
multiflora *Eckl. & Zeyh. GR 3505a; Ph 418; Tu 249.*
tenuifolia *Eckl. & Zeyh.* var. tenuifolia *Ph 981; Tu 260.*
3665 Melolobium alpinum *Eckl. & Zeyh. Ph & Hu 149.*
3673 Argyrolobium
baptisioides *Walp. Br 170; GR 3499a.*
crassifolium *Eckl. & Zeyh. Tu 259.*
longifolium *Walp. Ph 1163, 1237.*
molle *Eckl. & Zeyh. Gi 1142; Ph 98.*
pilosum *Harv. GR 3470, 3506a; Gi 1326; Ph 1161.*
speciosum *Eckl. & Zeyh. Gi s.n.; Ph & Hu 50.*
stipulaceum *Eckl. & Zeyh. Ph 1216.*
sutherlandii *Harv. Ph 1162.*
tomentosum *(Andr.) Druce Gi 334, 763, 979.*
tuberosum *Eckl. & Zeyh. Fu* et al. *46; Ph 1295, 1349.*
3681 Ulex europaeus *L. Gi 34, s.n.*
3688 Medicago lupulina *L. Ph 920.*
3690 Trifolium
burchellianum *Ser.* subsp. burchellianum *GR 3494, 3502a; Gi 719, 1146; Ph 395.*
repens *L. GR 3816.*
3702 Indigofera
alpina *Eckl. & Zeyh. Br 116; Ph 417.*
amatolensis *Phillipson Ph 427; Ph & Hu 9, 139.*
cuneifolia *Eckl. & Zeyh. Gi 67, 335, 487, 1126, 1252; Ph 334; Robinson 1061; Tu 209.*
evansii *Schltr. Gi 1530; Ph 404.*
hedyantha *Eckl. & Zeyh. Br 166; Gi 1230; Ph & Hu 129.*
mollis *Eckl. & Zeyh. Ph & Hu 153.*
monostachya *Eckl. & Zeyh. Br 115; Fu & Ph 71, 353, 354.*
stricta *L. f. Gi 1098, 1647; Ph 146.*
woodii *H. Bol. Gi 239; Ph 1015.*
sp. *Ph 403.*
3703 Psoralea pinnata *L. Fu & Ph 220; GR 3495a, 3821; Gi 336, 493, g840, 1253, 1646; Ph 164, 340, 821.*
3703c Otholobium
caffrum *(Eckl. & Zeyh.) C.H. Stirton Fu & Ph 229; Gi 233, 1310; McGillivray 15.*
stachyerum *(Eckl. & Zeyh.) C.H. Stirton GR 3498a.*
3718 Tephrosia
capensis *(Jacq.) Pers.* var. capensis *Ph 1018.*
grandiflora *(Ait.) Pers. Gi 270; Ph 148, 956.*
macropoda *E. Mey. Ph 1238.*
marginella *H.M. Forbes Gi 1240.*
polystachya *E. Mey. Gi 162; Ph 1039.*
3754 Sutherlandia frutescens *R. Br. Ph 1134.*
3756 Lessertia
flexuosa *E. Mey. Fu & Ph 140.*
harveyana *L. Bol. Gi 1099.*
perennans *DC.* var. perennans *Gi 1113; Ph & Hu 125.*
3807 Desmodium repandum *(Vahl) DC. Gi 837; Ph 1038.*
3810 Alysicarpus rugosus *(Willd.) DC.* subsp. perennirufus *J. Leonard Gi 1070; Ph 1180.*
3852 Vicia spp. Seen at various localities as weeds of cultivation.
3897 Rhynchosia
angulosa *Schinz Ph 1309.*
argentea *Harv. Gi 1107, 1190, 1313.*
caribaea *(Jacq.) DC. Ph 1029.*
cooperi *(Harv. ex Bak. f.) Burtt Davy Ph 1189, 1302.*
harmsiana *Schltr. ex Zahlbr.* var. burchellii *Burtt Davy Ph 1312.*
3898 Eriosema acuminata *(Eckl. & Zeyh.) C.H. Stirton Ph 1019, 1184, 1314.*

3905 Vigna vexillata *(L.) A. Rich. Gi 1064; Ph 139.*
3909 Lablab purpureus *(L.) Sweet* subsp. uncinatus *Verdc. Gi 160, 817, g892.*
3910 Dolichos
angustifolius *Eckl. & Zeyh. Ph 1311.*
linearis *E. Mey. Ph 549, 1213.*

GERANIACEAE
3924 Geranium
amatolicum *Hilliard & Burtt Gi 311; Ph 933, 953, 1000; Ph & Hu 20, 118; Robinson 1062.*
baurianum *Knuth Br 105, 111; Fu & Ph 70; GR 3486; Gi 21; Ph 422, 999.*
caffrum *Eckl. & Zeyh. Gi 1133.*
contortum *Eckl. & Zeyh. Br 148; Gi 226.*
discolor *Hilliard & Burtt Fu & Ph 54, 228; GR 3505; Gi 193, 1112, 1306; Ph 976.*
harveyi *Briq. Ph 1144.*
molle *L. Ph & Hu 133.*
multisectum *N.E. Br. Ph 799; Ph & Hu 146.*
ornithopodon *Eckl. & Zeyh. Gi 505, 918, 1094; Ph 932.*
schlechteri *Knuth Fu 694.*
wakkerstroomianum *Knuth Gi 303, 1309; Ph 1007.*
3925 Monsonia emarginata *(L. f.) L'Hérit. Gi 301, 1143.*
3927 Erodium cicutarium *(L.) L'Hérit. ex Ait. Ph & Hu 134.*
3928 Pelargonium
alchemilloides *(L.) L'Hérit. Gi 95; Ph 143, 1068.*
althaeoides *(L.) L'Hérit. Ph & Hu 125.*
caffrum *(Eckl. & Zeyh.) Harv. Ph & Hu 137.*
cordifolium *(Cav.) Curt. Fu & Ph 224; Gi 308, 1121; Ph 419; Robinson 1060.*
grossularioides *(L.) L'Hérit. Gi 302; Ph 1073.*
iocastum *(Eckl. & Zeyh.) Steud. Gi 1183, 1329, s.n.; Ph & Hu 114.*
multicaule *Jacq.* subsp. multicaule *Gi 1136; Ph 971.*
peltatum *(L.) L'Hérit. Gi 139.*
ranunculophyllum *(Eckl. & Zeyh.) Bak. Ph 1476, 1540.*
reniforme *Curtis Ph 550.*
schizopetalum *Sweet Gi 1119; Ph & Hu 57.*
sidifolium *(Thunb.) Knuth Ph & Hu 142.*
zonale *(L.) L'Hérit. Gi 310, 867, 1100; Ph 151, 392; Tu 204.*

OXALIDACEAE
3936 Oxalis
bifurca *Lodd.* var. bifurca *Ph & Hu 151.*
corniculata *L. Ph 924.*
semiloba *Sond. Br 125; Fu & Ph 341; GR 3524; Ph 1029, 1228 (double flowers), 1275; Ph & Hu 70.*
smithiana *Eckl. & Zeyh. Br 88a; GR 3422; Ph 1064; Ph & Hu 37.*
tragopoda *Salter Gi 1460.*

LINACEAE
3943 Linum
bienne *Mill. Fu & Ph 183.*
thunbergii *Eckl. & Zeyh. Br 162, 184; Fu & Ph 116, 142; Gi 241, 300, 1074, 1234.*

RUTACEAE
3991 Xanthoxylum
capense *(Thunb.) Harv. Fu & Ph 288; Gi 1060.*
davyi *(Verdoorn) Waterm. Gi 1439; Ph 900a, 1462.*
4035 Calodendrum capense *(L. f.) Thunb. Ph 1048.*
4038 Agathosma ovata *(Thunb.) Pillans Ph 895.*
4076 Vepris lanceolata *(Lam.) G. Don Fu s.n.; Gi 895.*
4091 Clausena anisata *(Willd.) Hook. f. ex Benth. Gi 71.*

BURSERACEAE
4151 Commiphora woodii *Engl.* Pefferskop, *Acocks 11900* (Van der Walt 1973: 85).

PTAEROXYLACEAE
4157 Ptaeroxylon obliquum *(Thunb.) Radlk. Ph 1117.*

MELIACEAE
4193 Ekebergia capensis *Sparrm. Ph 1119.*

POLYGALACEAE
4273 Polygala
confusa *Macowan Gi 291; Ph 107.*
fruticosa *Berg. Ph 967.*
hispida *Burch. Fu & Ph 114; Gi 242, 287, 1088, 1304; Ph 393; Ph & Hu 22.*
hottentotta *Presl Br 173; Fu* et al. *13; Fu & Ph 115.*
myrtifolia *L. Gi 1565; Ph 894.*
ohlendorfiana *Eckl. & Zeyh. Br 151; Fu & Ph 55; Gi g718; Ph 391, 986.*
refracta *DC. Ph 1263.*
uncinata *E. Mey. ex Meisn. Fu & Ph 89.*
virgata *Thunb. Ph 582.*
4278 Muraltia
alticola *Schltr. Ph 439.*
macroceras *DC. GR 3492; Gi 195, 247, 1124, s.n.; Ph 414.*
saxicola *Chod. Ph 436.*
4279 Nylandtia spinosa *(L.) Dumort. Ph 1126.*

EUPHORBIACEAE
4299 Phyllanthus incurvus *Thunb. Ph 1232.*
4348 Croton rivularis *E. Mey. Gi 1468; Ph 835.*
4370 Adenocline
acuta *(Thunb.) Baill. Gi 1443, 1535.*
pauciflora *Turcz. Fu & Ph 359; Gi 232, g748.*
4372 Leidesia obtusa *(Thunb.) Muell. Arg. Gi 1546.*
4407 Acalypha
ecklonii *Baill. GR 3010; Ph 1183.*
peduncularis *E. Mey. ex Meisn. Fu & Ph 230, 352; Gi 992, 1024, 1028, 1154, 1181, 1264.*
4416a Ctenomeria capensis *(Thunb.) Harv. ex Sond. Gi 164, 883, 886, 976, 1506.*
4424 Ricinus communis *L. Ph 1049.*
4448 Clutia
affinis *Sond. GR 3822; Gi 41, 70, 412, 768, g886; Mahlobo 41; Ph 150.*
alaternoides *L.* (var. not determined) *Fu & Ph 345; Gi 416, 769; Ph 407; Tu 208.*
disceptata *Prain Gi 1169.*
heterophylla *Thunb. Fu & Ph 296; Gi 1111; Ph 1201; Ph & Hu 77.*
hirsuta *E. Mey. ex Sond.* var. hirsuta *Ph 962.*
katharinae *Pax Fu & Ph 39; Ph 558.*
natalensis *Bernh. ex Krauss Tu 168, 169, 171.*
pulchella *L.* var. pulchella *Fu & Ph 268; Ph 503; Tu 255.*
4498 Euphorbia
epicyparissias *E. Mey. ex Bioss.* var. epicyparissias *Fu 35; Gi 40, 765, 766; Ph 409; Tu 231.*
kraussiana *Bernh.* (var. not determined) *Gi 764; Mahlobo 42.*
pulvinata *Marloth.* Seen among rocks on Gaika's Kop and neighbouring peaks.
sclerophylla *Boiss. Fu & Ph 61; GR 3429.*
striata *Thunb. Fu & Ph 109.*
4498b Chamaesyce inaequilatera *(Sond.) Sojak Ph 1047.*

ANACARDIACEAE
4562 Harpephyllum caffrum *Bernh. Fu s.n.; Tu 188.*
4594 Rhus
chirindensis *Bak. f. Fu s.n.; Fu & Ph 252; Gi 579, 994, 1059.*
dentata *Thunb. Fu & Ph 284, 294; Gi g882, 991; Ph 548; Tu 141.*
dentata *Thunb.* x R. divaricata *Eckl. & Zeyh. Tu 136.*
discolor *E. Mey. ex Sond. Gi 1308; Ph 545.*
fastigiata *Eckl. & Zeyh. Fu & Ph 311; Ph 244.*
fastigiata *Eckl. & Zeyh.* x R. rehmanniana *Engl. Fu & Ph 310; Gi g884.*
incisa *L. f.* var. effusa *(Presl) R. Fernandes Ph 794.*
krebsiana *Presl ex Engl. Tu 270* (possibly crossed with R. divaricata Eckl. & Zeyh.).

pallens *Eckl. & Zeyh.* forma pallens *Robinson 1071.*
pyroides *Burch.* var. gracilis *(Engl.) Burtt Davy Gi 1241, 1294, 1305, 1349.*
pyroides *Burch.* var. pyroides *Gi 323, 324; Ph 552; Russell 2339; Tu 117, 120, 121, 129.*
rehmanniana *Engl. Fu & Ph 308; Gi g883.*
tomentosa *L. Ph 333; Robinson 1070, 1501, s.n.; Tu 239.*

AQUIFOLIACEAE
4614 Ilex mitis *(L.) Radlk. Fu s.n.; Gi 136.*

CELASTRACEAE
4626 Maytenus
acuminata *(L. f.) Loes* var. acuminata *Ph 761, 777, 868; Tu 210.*
heterophylla *(Eckl. & Zeyh.) N.K.B. Robson Fu & Ph 264; Ph 785, 795, 873; Tu 202.*
nemorosa *(Eckl. & Zeyh.) Marais Gi 496, 535, g851, 892; Ph 781, 881, 887; Tu 213.*
peduncularis *(Sond.) Loes. Ph 872, 882; Tu 216.*
undata *(Thunb.) Blakelock Ph 764.*
4628 Putterlickia verrucosa *(E. Mey. ex Sond.) Szyszyl. Gi 1102; Ph 896.*
4630 Pterocelastrus tricuspidatus *(Lam.) Sond. Gi 316.*
4641 Cassine
aethiopica *Thunb. Fu s.n.; Ph 901.*
papillosa *(Hochst.) Kuntze Fu s.n.; Fu & Ph 265; Gi 773; Ph 883, 900b, 1125.*
tetragona *(L. f.) Loes Ph 871.*

ICACINACEAE
4671 Cassinopsis ilicifolia *(Hochst.) Kuntze Fu s.n.; Ph 1124, 1318.*
4686 Apodytes dimidiata *E. Mey. ex Arn.* subsp. dimidiata *Tu 205.*

SAPINDACEAE
4734 Allophylus decipiens *(Sond.) Radlk. Fu s.n.; Fu & Ph 271; Ph 779; Tu 184.*
4836 Hippobromus pauciflorus *(L. f.) Radlk. Gi 533, 1036; Tu 178.*

MELIANTHACEAE
4854 Melianthus
dregeanus *Sond.* subsp. dregeanus *Gi g841, 1526; Ph 415; Tu 245.*
major *L. Gi s.n.*

BALSAMINACEAE
4856 Impatiens hochstetteri *Warb.* subsp. hochstetteri *GR 3128; Gi 312; Mgudlwa 25; Ph 162.*

RHAMNACEAE
4861 Ziziphus mucronata *Willd.* subsp. mucronata *Fu & Ph 291; Ph 104.*
4874 Scutia myrtina *(Burm. f.) Kurz Fu s.n.; Fu & Ph 295; Gi 1063; Mahlobo 12; Tu 203.*
4875 Rhamnus prinoides *L'Hérit. Fu s.n.; Gi 68, 251, 1520; Ph 553.*
4880 Noltia africana *(L.) Reichb. f. Fu & Ph 285; Gi 1585; Ph 589.*
4886 Phylica galpinii *Pillans Gi 276; Ph 566.*
4905 Helinus integrifolius *(Lam.) Kuntze Fu & Ph 254; Gi 1084; Ph 796.*

VITACEAE
4917 Rhoicissus
digitata *(L. f.) Gilg & Brandt Tu 189.*
microphylla *(Turcz.) Gilg & Brandt Ph 554, 1342; Tu 137, 142, 149.*
revoilii *Planch. Gi g881; Ph 763.*
tridentata *(L. f.) Wild & Drum.* subsp. cuneifolia *(Eckl. & Zeyh.) N.R. Urton Fu & Ph 258; Gi 573.*
4918a Cyphostemma cirrhosa *(Thunb.) Desc. Gi 578, 1067; Ph 147.*

TILIACEAE
4957 Sparrmannia ricinocarpa *(Eckl. & Zeyh.) Kuntze Gi 271.*
4966 Grewia occidentalis *L. Fu & Ph 274; Tu 191.*

MALVACEAE
4983 Abutilon sonneratianum *(Cav.) Sweet Ph 159.*
4986a Anisodontea scabrosa *(L.) Bates Ph 511.*
4998 Sida
rhombifolia *L. Ph 1033.*
ternata *L. f. Gi 1541; Russell 2356.*
5007 Pavonia columella *Cav. Gi g844; Ph 1042.*
5013 Hibiscus
aethiopicus *L.* var. aethiopicus *Gi 1083.*
trionum *L. Gi 1086; Ph 386.*

STERCULIACEAE
5056 Hermannia
erodioides *(Burch. ex DC.) Kuntze Ph 820, 914.*
geniculata *Eckl. & Zeyh. Ph 1475.*
velutina *DC. Gi 297; Ph 590; Tu 186.*

OCHNACEAE
5112 Ochna serrulata *(Hochst.) Walp. Fu s.n.; Fu & Ph 262; GR 3820; Gi 314; Ph 875.*

CLUSIACEAE
5168 Hypericum
aethiopicum *Thunb.* subsp. aethiopicum *GR 3428.*
lalandii *Choisy Br 27; Fu & Ph 143; Gi 299, 731, 1077.*
natalense *Wood & Evans Gi 1139.*

VIOLACEAE
5271 Hybanthus capensis *(Thunb.) Engl. Ph 1523.*
5274 Viola arvensis *Murray Ph 984; Ph & Hu 23.*

FLACOURTIACEAE
5296 Kiggelaria africana *L. Gi 285; Tu 131, 206.*
5304 Scolopia
mundii *(Eckl. & Zeyh.) Warb. Fu s.n.; Gi 891; Ph 760, 784.*
zeyheri *(Nees) Harv. Fu s.n.; Tu 268.*
5315 Trimeria
grandifolia *(Hochst.) Warb. Fu & Ph 260; Gi s.n.*
trinervis *Harv. Gi 1159; Ph 772, 798; Tu 185.*
5328 Dovyalis
lucida *Sim*, Hogsback, *Story 369* (Langenegger 1976: 90).
zeyheri *(Sond.) Warb. Ph 789; Tu 180.*

ACHARIACEAE
5374 Ceratiosicyos laevis *(Thunb.) A. Meeuse Gi 1022, 1441, 1654; Ph 502.*
5375 Acharia tragodes *Thunb. Ph 1197.*

CACTACEAE
5417 Opuntia spp. (seen occasionally in disturbed places).

THYMELAEACEAE
5435 Gnidia
baurii *C.H. Wr. GR 3440; Ph 563.*
nodiflora *Meisn. Gi 1109; Ph 389.*
phaeotricha *Gilg Gi 248; Ph & Hu 63, 95.*
pulchella *Meisn. Fu & Ph 286; Gi 250, 485; Ph 243; Tu 237.*
sericea *L.* var. sericea *Fu 677; Gi 415, 486; McGillivray 23; Ph 341, 405.*
5436 Struthiola parviflora *Bartl. ex Meisn. Ph 1202.*
5438 Englerodaphne pilosa *Burtt Davy Fu 58; Gi 208, 559.*
5461 Passerina
filiformis *L. Ph 1200.*
montana *Thoday Ph 1140; Tu 170.*
vulgaris *Thoday Gi s.n.; Tu 217.*

sp. Between the Wolf and Mnyameni Rivers (Story 1952: 99).
5465 Dais cotinifolia *L. Ph 736.*

LYTHRACEAE
5476 Lythrum hyssopifolium *L. Gi 1346.*

MYRTACEAE
5578 Eugenia zeyheri *Harv. Fu & Ph 251.*
5598 Eucalyptus sp. (seen naturalized, mainly near plantations).

ONAGRACEAE
5795 Epilobium capense *Buch. ex Hochst. Br 23, 160, 169, 178; Fu* et al. *15; Fu & Ph 226; Gi 221, 1178.*
Epilobium
hirsutum *L. Gi 975; Ph 1045.*
tetragonum *L.* subsp. tetragonum *Br 133, 175; Fu 717.*
5804 Oenothera rosea *Ait. Ph 397, 925.*

HALORAGACEAE
5833 Laurembergia repens *Berg.* (intermediate between subspecies, see Obermeyer 1973) *Fu & Ph 6; Ph 1325.*
5836 Gunnera perpensa *L. Gi 1042, 1244; Ph 396.*

ARALIACEAE
5872 Cussonia
paniculata *Eckl. & Zeyh. Gi 1161; Ph & Hu 66; Tu 140, 148.*
spicata *Thunb. Mgobozi 21; Tu 176.*

APIACEAE
5894 Centella
asiatica *(L.) Urb. GR 3404; Gi 362, 469, g887; Ph 336.*
glabrata *L.* var. natalensis *Adamson GR 3472; Gi 363, 1237.*
5918 Sanicula elata *Buch.-Ham. GR 3811; Gi 141, 366, s.n.*
5922 Alepidea
acutidens *Weim.*, Nyameni Location, near Keiskama Hoek, 3 500 ft, *Schonland 4461* (GRA, PRE) (Weimarck 1949: 245).
amatymbica *Eckl. & Zeyh.* var. amatymbica *GR 3502.*
amatymbica *Eckl. & Zeyh.* var. aquatica *(Kuntze) Weim. Fu* et al. *36; GR 224.*
capensis *(Berg.) R.A. Dyer* var. capensis *GR 3443, 3488a; Gi 506; Ph 1463, 1468.*
macowanii *Duemmer Ph 1269.*
pilifera *Weim. Fu & Ph 149, 349; Ph & Hu 52.*
serrata *Eckl. & Zeyh.* var. cathcartensis *(Kuntze) Weim. Gi 1260.*
serrata *Eckl. & Zeyh.* var. serrata *Gi 220, 1327; Ph & Hu 74.*
5970 Conium
chaerophylloides *(Thunb.) Sond. Fu & Ph 346.*
fontanum *Hilliard & Burtt* var. alticola *Hilliard & Burtt Ph 1001.*
fontanum *Hilliard & Burtt* var. fontanum, Thomas Mtn, *Hilliard & Burtt 14798* (E, NU) (Hilliard & Burtt 1985: 472).
sp. Hogsback Forest Reserve, *Hilliard & Burtt 10992* (E, NU) (Hilliard & Burtt 1985: 472).
5990 Lichtensteinia interrupta *(Thunb.) E. Mey. Ph 1186.*
5992 Heteromorpha arborescens *(Spreng.) Cham. & Schlechtd. Tu 267.*
5994 Bupleurum mundtii *Cham. & Schlechtd. GR 3508; Ph 1014; Ph & Hu 44* (KEI).
6004a Ciclospermum leptophyllum *(Pers.) Sprague Ph 1032.*
6017a Sonderina humilis *(Meisn.) Wolff Ph 905, 1033.*
6033 Pimpinella caffra *(Eckl. & Zeyh.) D. Dietr. Ph 825, 1061, 1283.*
6038 Sium repandum *Welw. ex Hiern Fu & Ph 195.*
6045 Polemannia
grossulariifolia *Eckl. & Zeyh. Gi 1296, s.n.; Tu 153.*
montana *Schltr. & Wolff*, Gaika's Kop, *Hilliard & Burtt 18805* (E, NU) (Hilliard & Burtt unpublished).
6078 Annesorrhiza schlechteri *Wolff Fu 20; Fu & Ph 25, 106.*
6078b Stenosemis angustifolia *Sond. Ph 1021.*
6116 Peucedanum
caffrum *(Meisn.) Phill. Ph & Hu 43.*
capense *(Thunb.) Sond.* var. lanceolatum *(E. Mey. ex Meisn.) Sond. Gi 69, 368; Ph & Hu 30; Tu 238.*
6142 Daucus carota *L. Tu 100.*

CORNACEAE
6156 Curtisia dentata *(Burm. f.) C.A. Sm. Gi g849.*

ERICACEAE
6237 Erica
alopecurus *Harv.* var. alopecurus *Gi s.n.; Ph 437, 570.*
brownleeae *H. Bol. Fu & Ph 20, 216, 241; GR 3496a; Gi 25, 1321; Ph & Hu 111.*
caespitosa *Hilliard & Burtt Fu & Ph 112, 239; Ph & Hu 12; Ph 1256.*
caffra *L. Gi 698a, s.n.*
caffrorum *H. Bol.* var. caffrorum *Ph 435, 441; Ph & Hu 8.*
frigida *H. Bol. Ph & Hu 6.*
leucopelta *Tausch.* var. leucopelta *Gi s.n.; Ph & Hu 147; Tu 251.*
maesta *H. Bol. Fu & Ph 40, 41; Gi 22; Ph & Hu 33.*
woodii *H. Bol.* subsp. woodii *Ph 1220.*
woodii *H. Bol.* subsp. platyura *Hilliard & Burtt*, Hogsback, *Rattray 216* (PRE) (Hilliard & Burtt 1986).
sp. *Ph 1142.*
6241 Ericinella multiflora *Klotzsch Fu & Ph 221; Gi 1320; Ph & Hu 110; Tu 248, 252.*

MYRSINACEAE
6283 Maesa alnifolia *Harv. Fu & Ph 261; Gi 65, 401, 531, 937.*
6313 Myrsine africana *L. GR 3021; Gi 146, 537; Ph 342, 424; Tu 139, 226.*
6314 Rapanea melanophloeos *(L.) Mez Fu s.n.; Gi 74; Tu 199.*

PRIMULACEAE
6330 Lysimachia nutans *Nees Gi 231, 771, 1135; Ph & Hu 117.*
6338 Anagallis huttonii *Harv. Br 177; Fu 690, 720; Fu 04; Fu & Ph 24.*

PLUMBAGINACEAE
6343 Plumbago auriculata *Lam. Ph 102.*

SAPOTACEAE
6386 Mimusops obovata *Sond. Fu & Ph 259; Ph 880.*

EBENACEAE
6404 Euclea
crispa *(Thunb.) Guerke* var. crispa *Fu & Ph 289; Ph 773; Tu 187, 232, 233.*
schimperi *A. DC.* var. schimperi *Ph 1120.*
undulata *Thunb.* var. undulata, Elandsberg (Story 1952: 93).
6406 Diospyros
austro-africana *De Winter* var. microphylla *(Burch.) De Winter Ph 547; Tu 143, 144, 147.*
dichrophylla *(Gand.) De Winter Gi 1528; Tu 262.*
lycioides *Desf.* subsp. sericea *(Bernh.) De Winter Fu & Ph 292.*
scabrida *(Harv. ex Hiern) De Winter* var. cordata *(E. Mey. ex A. DC.) De Winter Ph 889.*
simii *(Kuntze) De Winter Ph 776, 790.*
villosa *L.* var. villosa *Fu & Ph 253; Gi 978; Tu 201.*
whyteana *(Hiern) F. White Ph 1116; Tu 200.*

OLEACEAE
6428 Chionanthus foveolata *(E. Mey.) Stearn* subsp. foveolata *Fu s.n.; Gi g842.*
6434 Olea
capensis *L.* subsp. macrocarpa *(C.H. Wright) Verdoorn Fu s.n.*
europaea *L.* subsp. africana *(Mill.) P.S. Green Tu 271.*

LOGANIACEAE
6473 Buddleja
auriculata *Benth. Ph 828, 831.*
dysophylla *(Benth.) Radlk. Gi 413; Tu 175.*

saligna *Willd.* *Tu 173.*
salvifolia *(L.) Lam.* *Fu & Ph 46, 231; Gi 475, 536, 705; Tu 127, 128, 172.*

GENTIANACEAE
6481 Sebaea
hymenosepala *Gilg* *Fu & Ph 94; Gi 1141, 3504.*
longicaulis *Schinz* *Gi 1021, s.n.; Ph 141, 433.*
macrophylla *Gilg* *Gi 470, s.n.; McGillivray 30.*
repens *Schinz* *Br 78; Ph 438.*
sedoides *Gilg* var. confertiflora *(Schinz) Marais* *Fu & Ph 17; Ph 1271.*
thomasii *S. Moore* *Fu & Ph 48.*
6503 Chironia krebsii *Griseb.* *Fu & Ph 11, 92; Gi 1116; GR 3515a.*

APOCYNACEAE
6559 Carissa
bispinosa *(L.) Desf.* var. acuminata *(E. Mey.) Codd* *Gi 96, 930; Ph 111.*
bispinosa *(L.) Desf.* var. bispinosa *Fu & Ph 257.*
6688 Strophanthus speciosus *(Ward & Harv.) Reber* *Fu & Ph 270; Ph 829, 1154.*

ASCLEPIADACEAE
6777 Xysmalobium
involucratum *Decne.* *Ph 960; Ph & Hu 61.*
orbiculare *D. Dietr.* *Ph 1160.*
parviflorum *Harv. ex Scott Elliott* *Ph 1274; Ph & Hu 47.*
prunelloides *Turcz.* *Fu & Ph 355; Ph 977; Ph & Hu 97.*
stockenstromense *Scott Elliott* *Ph & Hu 152.*
undulatum *(L.) Ait. f.* *Ph 1195.*
6778 Schizoglossum
atropurpureum *E. Mey.* subsp. tridentatum *(Schltr.) Kupicha* *Gi 243; Ph 1307; Ph & Hu 102.*
cordifolium *E. Mey.* *Ph & Hu 140.*
hamatum *E. Mey.*, Hogsback Mtn, *Rattray 269* (BOL); *Rattray 15764* (BOL) (Kupicha 1984: 605).
6778a Aspidoglossum gracile *(E. Mey.) Kupicha* *Ph 1262.*
6779 Fanninia caloglossa *Harv.* *GR 3484a; Ph 1157.*
6787a Pachycarpus concolor *E. Mey.* *Ph 1231.*
6791 Asclepias
diploglossa *(Turcz.) Druce* *Gi s.n.; Ph 998; Ph & Hu 148.*
fruticosa *L.* *Gi 1038.*
gibba *(E. Mey.) Schltr.* *Gi 1156; Ph 775.*
peltigera *(E. Mey.) Schltr.* *Ph 1168.*
physocarpa *(E. Mey.) Schltr.* *Gr 3009; Gi 1057, 1078; Ph 958.*
stellifera *Schltr.* *Ph 1133.*
6834 Cynanchum ellipticum *(Harv.) R.A. Dyer* *Fu & Ph 269b; Gi 525.*
6849 Sarcostemma viminale *(L.) R. Br.* *Ph 1495.*
6860 Secamone
alpinii *Schultes* *Gi g839.*
filiformis *(L. f.) J.H. Ross* *Fu & Ph 269; Gi 1097.*
6861 Sisyranthus barbatus *(Turcz.) N.E. Br.* *GR 3480; Ph & Hu 99.*
6868 Anisotoma cordifolia *Fenzl* *Gi s.n.; Ph & Hu 85.*
6875 Riocreuxia torulosa *Decne.* *Gi 228, 1134, 1183a.*
6899 Tylophora
cordata *(Thunb.) Druce* *Gi 1104.*
flanaganii *Schltr.* *Ph 1118.*

CONVOLVULACEAE
6968 Cuscuta
appendiculata *Engelm.* *Gi 225.*
cassytoides *Nees ex Engelm.* *Gi s.n.*
6993 Convolvulus farinosus *L.* *Gi 1080; Ph 1308.*
7003 Ipomoea purpurea *(L.) Roth* *Ph 1330.*

BORAGINACEAE
7043 Ehretia rigida *(Thunb.) Druce* *Tu 179.*
7064 Cynoglossum
enerve *Turcz.* *Ph 1066, 1185.*
hispidum *Thunb.* *Gi 1027.*
lanceolatum *Forssk.* *Hughes and Mjwara 32; Ph 1492.*
spelaeum *Hilliard & Burtt* *Gi 722a; Ph 1294.*
7100 Myosotis
sylvatica *Hoffm.* *Fu & Ph 184.*
semiamplexicaulis *DC.* *Ph 1004.*
7109 Lithospermum papillosum *Thunb.* *Gi 1144, 1170; Ph 92.*
7118 Echium sp. Seen as a weed in ploughed land.

VERBENACEAE
7138 Verbena
bonariensis *L.* *Ph 1031; Russell 2348.*
venosa *Gill. & Hook.* *Ph 91.*
7153 Priva meyeri *Jaub. & Spach* var. meyeri *Ph 1236.*

LABIATAE
7211 Ajuga ophrydis *Burch. ex Benth.* *Fu & Ph 315; GR 3419.*
7212 Teucrium trifidum *Retz.* *Ph 1235.*
7238 Marrubium vulgare *L.* *Ph 1303.*
7264 Leonotis
leonurus *(L.) R. Br.* var. leonurus *Fu & Ph 290; Gi 908, 1518; McGillivray 34; Tu 265.*
ocymifolia *(Burm. f.) Iwarsson* var. ocymifolia *Fu & Ph 297; Ph 1214.*
ocymifolia *(Burm. f.) Iwarsson* var. raineriana *(Visiani) Iwarsson* *Gi 1438, 1519; Mahlobo 20, Ph 1041.*
7281 Stachys
aethiopica *L.* *Ph 1100, 1544; Ph & Hu 169.*
caffra *E. Mey. ex Benth.* *Gi s.n.*
flexuosa *Skan* *GR 3517; Ph 1478; Ph & Hu 11, 161.*
graciliflora *Presl* *Gi 574, g808, 1475, 1547; Ph 108, 1472.*
grandiflora *E. Mey. ex Benth.* *Ph 934, 1543, 1546; Ph & Hu 160.*
humifusa *Burch. ex Benth.* *Ph 1326.*
malacophylla *Skan* *Ph 1479.*
sp. 1 *Ph 963, 1234, 1464.*
sp. 2 *Ph 1547.*
sp. 3 *Ph 1002, 1259; Ph & Hu 41, 159.*
7290 Salvia
aurita *Thunb.* var. aurita, Tyumie Berg, *Ecklon* (Hedge 1974: 67).
aurita *Thunb.* var. galpinii *(Skan) Hedge* *Gi g896, 1476.*
repens *Burch. ex Benth.* var. repens *Gi 1140, 1511; Ph 97, 160; Ph & Hu 103.*
verbenaca *L.* *Ph 1129.*
7328 Mentha
aquatica *L.* *Br 174; Fu 739, 742; Gi 906.*
longifolia *(L.) Huds.* subsp. capensis *(Thunb.) Briq.* *Fu & Ph 76.*
7350 Plectranthus
ambiguus *(H. Bol.) Codd* *Ph 1250.*
ciliatus *E. Mey. ex Benth.* *Gi 1539.*
ecklonii *Benth.* *Gi 440, 580, 1459, 1541a; Ph 161.*
fruticosus *L'Hérit.* *Ph 1209.*
grallatus *Briq.*, Hogsback, *Johnson 1289, 1308* (Codd 1975: 419).
grandidentatus *Guerke* *Gi 1522.*
laxiflorus *Benth.* *Gi 827, 1467, 1534, 1547a; Mahlobo 25; Tyibilika 46.*
strigosus *Benth.* *Gi 492, g894, 1035.*
verticillatus *(L. f.) Druce* *Ph 1037.*
7350c Rabdosiella calycina *(Benth.) Codd* *Gi 1016, s.n.*
7359 Syncolostemon densiflorus *Benth.* *GR 3496, 3497a.*

SOLANACEAE
7400 Withania somnifera *(L.) Dun.* *Ph 966.*
7401 Physalis peruviana *L.* *Ph 1497.*
7407 Solanum
aculeatissimum *Jacq.* *Ph 1198.*
burbankii *Bitter* *Ph 1355.*
giganteum *Jacq.* *Gi 1086, 1437; Ph 1253.*
linnaeanum *Hepper & Jaeger* *Ph 949.*

pseudo-capsicum *L. Ph 1251.*
retroflexum *Dun. Ph 1077, 1354; Russell 2355.*
rigescens *Jacq. Ph 972.*
sarrachoides *Sendtner Ph 1353.*

SCROPHULARIACEAE (Part A)
7471 Diascia
mollis *Hilliard & Burtt*, Hogsback, Bongo Mts 5 000 ft, *Sidey 706* (PRE) (Hilliard & Burtt 1984: 291).
rigescens *Benth. GR 3485; Gi 720a, 1312; Ph 412; Ph & Hu 31; Robinson s.n.*
7476 Nemesia
melissifolia *Benth. Gi 719a; Ph 565, 886, 1024, 1059, 1261; Ph & Hu 126.*
umbonata *(Hiern) Hilliard & Burtt Fu & Ph 351; Gi g727; Ph & Hu 48, 128.*
7477 Diclis
reptans *Benth. Gi 278, 1299, 1600, 1601; Ph 335.*
rotundifolia *(Hiern) Hilliard & Burtt Ph 1172, 1465.*
7480 Linaria vulgaris *Mill. Ph 1088.*
7493 Halleria lucida *L. Fu & Ph 307; Gi 60, 1608; Tu 224.*
7494 Teedia lucida *Rudolphi Gi 192.*
7495 Phygelius capensis *E. Mey. ex Benth. Fu & Ph 283; Gi 268.*
7500 Bowkeria verticillata *(Eckl. & Zeyh.) Schinz Gi 143, 1248; Ph 769.*
7519 Sutera
aurantiaca *(Benth.) Hiern Ph 1101.*
campanulata *(Benth.) Hiern Ph 157.*
pauciflora *(Benth.) Kuntze Gi 1091.*
pinnatifida *Kuntze Ph 90, 158, 1331.*
7523 Zaluzianskya
angustifolia *Hilliard & Burtt Br 92; Gi 1440; Ph 421.*
ovata *(Benth.) Walp. Ph & Hu 143.*
spathacea *(Benth.) Walp. Gi 238; Ph 1278.*
7524 Mimulus gracilis *R. Br. Ph 1138.*
7558 Limosella
aquatica *L. Gi 64a.*
grandiflora *Benth. GR 3017.*
maior *Diels Fu & Ph 203; GR 3001; Gi 64b; Ph 495.*

SELAGINACEAE
7566 Hebenstretia
comosa *Hochst. Ph 1008.*
dura *Choisy GR 3521; Ph 429, 546; Tu 133.*
robusta *E. Mey. Gi 734a, 1125; Ph 406.*
7568 Selago
corymbosa *L. Fu & Ph 303; McGillivray 37.*
galpinii *Schltr. Ph & Hu 29; Rattray 260* (PRE); *Story 3505* (PRE).
7568a Walafrida polystachya *Rolfe Br 131; Fu & Ph 337.*

SCROPHULARIACEAE (Part B)
7579 Veronica anagallis-aquatica *L. Fu & Ph 185; Gi 1070a; Ph 136.*
7597 Melasma scabrum *Berg. Fu & Ph 155; Gi 1602; Ph 240.*
7597a Alectra
capensis *Thunb. Ph 1264.*
sessiliflora *(Vahl) Kuntze* var. sessiliflora *Ph 137.*
7614 Graderia scabra *(L. f.) Benth. Ph 1304.*
7616 Sopubia simplex *(Hochst.) Hochst. Ph 1279.*
7622 Buchnera
dura *Benth. Ph 1272.*
glabrata *Benth. Gi 1174.*
7623 Cycnium racemosum *Benth. Fu & Ph 138; Gi 209, 1122; Ph & Hu 10.*
7625 Striga bilabiata *(Thunb.) Kuntze Gi 223, 1071, 1173, 1606; Ph 138.*
7627 Harveya
coccinea *Schltr. Gi 213; Ph 801.*
huttonii *Hiern Fu & Ph 323.*
speciosa *Bernh. Fu 17; Gi 229, 1607.*
sp. aff. H. bolusii *Kuntze Gi 211, g706.*
7645 Bartsia trixago *L. Br 150; Gi 1182; Ph & Hu 26, 136.*

GESNERIACEAE
7823 Streptocarpus rexii *(Hook.) Lindl. Gi 39, 1548, s.n.*

LENTIBULARIACEAE
7901 Utricularia livida *E. Mey. Fu & Ph 32; Gi 1272, 1342, s.n.*

ACANTHACEAE
7941 Chaetacanthus setiger *(Pers.) Lindl. Ph 1233.*
7978 Sclerochiton odoratissimus *Hilliard Gi 1114; Ph 1190.*
8032 Hypoestes
forskaolii *(Vahl) R. Br. Gi 452.*
triflora *(Forssk.) Roem. & Schult. Gi 1009, 1543.*
8079 Isoglossa
cooperi *C.B. Cl. GR 3819; Gi g59, 1013; Ph 1115, 1199.*
eckloniana *(Nees) Lindau Gi 100, 829; Ph 1460.*
8094 Justicia campylostemon *(Nees) T. Anders. Ph 780.*

PLANTAGINACEAE
8116 Plantago
lanceolata *L. Fu & Ph 65.*
major *L. Ph 918.*

RUBIACEAE
8136 Kohautia amatymbica *Eckl. & Zeyh. Fu & Ph 350; GR 3479.*
8281 Burchellia bubalina *(L. f.) Sims GR 3500a; Gi 55, 56, 191, 1037, 1374.*
8283b Coddia rudis *(E. Mey. ex Harv.) Verdc. Ph 388.*
8285 Gardenia
amoena *Sims Gi s.n.; Ph 1127.*
thunbergii *L. f. Gi s.n.*
8285a Rothmannia capensis *Thunb. Ph 836.*
8348 Pentanisia prunelloides *(Klotzsch ex Eckl. & Zeyh.) Walp.* subsp. prunelloides *Fu* et al. *28; Fu & Ph 73; Gi 246.*
8352 Canthium
ciliatum *(Klotzsch) Kuntze Fu & Ph 272; Gi 508, 811, 888; Ph 504, 771, 787, 1123.*
inerme *(L. f.) Kuntze Fu s.n.; Fu & Ph 266, 276.*
mundianum *Cham. & Schlechtd. Fu s.n.; Fu & Ph 275; Gi 887.*
obovatum *Klotzsch Ph 1128.*
pauciflorum *(Klotzsch) Kuntze Fu & Ph 273.*
8383 Pavetta
capensis *(Houtt.) Brem.* subsp. komghensis *(Brem.) Kok Gi 1158.*
kotzei *Brem. GR 3501a.*
lanceolata *Eckl. Fu s.n.*
8399 Psychotria capensis *(Eckl.) Vatke GR 3835a; Ph 951.*
8435 Galopina
aspera *(Eckl. & Zeyh.) Walp. Ph 1461.*
circaeoides *Thunb. Fu 678; Gi 409; Russell 2357.*
8438 Anthospermum
herbaceum *L. f. Fu & Ph 104, 245; GR 3533; Gi 1025, 1075, 1228, 1445.*
paniculatum *Cruse Fu & Ph 63; GR 3529; Gi 1229.*
pumilum *Sond.* subsp. pumilum *Ph 96.*
spathulatum *Spreng.* subsp. spathulatum *Gi 147; Ph 413; Tu 236.*
8464 Richardia scabra *L. Ph 1051.*
8482 Sherardia arvensis *L. Fu & Ph 319; Ph & Hu 130.*
8486 Galium
amatymbicum *Eckl. & Zeyh. Ph & Hu 7.*
capense *Thunb.* subsp. capense *Fu 18; Ph 992.*
capense *Thunb.* subsp. garipense *(Sond.) Puff*, Hogsback, *Rattray 433* (PRE) (Puff 1978: 242).
scabrelloides *Puff Br 182; Fu & Ph 167; Gi 240, 371.*
thunbergianum *Eckl. & Zeyh.* var. hirsutum *(Sond.) Verdc. Ph 803.*
thunbergianum *Eckl. & Zeyh.* var. thunbergianum *Ph 1060.*
8489 Rubia petiolaris *DC. Gi 1095; Ph 544.*

VALERIANACEAE
8532 Valeriana capensis *Thunb. Fu & Ph 126; Gi 1177.*

DIPSACACEAE
8541 Cephalaria
humilis *(Thunb.) Roem. & Schult. Gi 1335; Ph 994.*
oblongifolia *(Kuntze) Szabo Fu & Ph 180; GR 3486a, 3515.*
8546 Scabiosa
columbaria *L. Fu & Ph 56, 59; Gi 1155; Ph 555, 988.*
tysonii *L. Bol. Gi 1191, 1301; Ph 556, 591; Russell 2340.*

CUCURBITACEAE
8564 Zehneria scabra *(L. f.) Sond.* subsp. scabra *GR 3501; Gi 282, 1194; Ph 1477.*
8628 Coccinea quinqueloba *(Thunb.) Cogn. Ph 1079.*

CAMPANULACEAE
8668 Wahlenbergia
capillacea *(L. f.) A. DC.* subsp. capillacea *Br 179; Ph 1339; Ph & Hu 121.*
cuspidata *V. Brehm. Ph 1258; Ph & Hu 4.*
huttonii *(Sond.) Thulin Fu & Ph 22.*
madagascariensis *A. DC. Gi 1090; Ph 923.*
paucidentata *Schinz GR 3523; Ph 989; Ph & Hu 35.*
procumbens *(Thunb.) A. DC. Gi s.n.; Ph 952, 1211.*
stellarioides *Cham. & Schlechtd. Ph 1208.*
undulata *(L. f.) A. DC. Ph 1226, 1240 (3-locular); Ph 1470 (2-locular).*
zeyheri *Eckl. & Zeyh. GR 3531; Gi 1072.*
sp. aff. W. undulata *Fu* et al. *56; Fu & Ph 72, 144.*
sp. *Ph 1327.*
8668a Craterocapsa montana *(A. DC.) Hilliard & Burtt Br 91; Fu & Ph 68; GR 3430; Gi 435; Ph 440, 912.*

LOBELIACEAE
8681 Cyphia natalensis *Phill. Gi 222; Ph 1179.*
8694 Lobelia
anceps *L. f. Ph 1207.*
angolensis *Engl. & Diels Fu 194.*
flaccida *(Presl) A. DC.* subsp. flaccida *Fu & Ph 69; GR 3493, 3513; Gi 500, 576; Ph 152, 500, 1205.*
preslii *A. DC. Ph & Hu 127.*
8695 Monopsis
decipiens *(Sond.) Thulin Br 22; Fu* et al. *01; Fu & Ph 107; Gi 277, 1270, 1328; Ph 491.*
scabra *(Thunb.) Urb. Fu & Ph 21, 57; Ph 144, 385, 497, 965, 1178, 1338, 1473.*
stellarioides *(Presl) Urb.* subsp. stellarioides *Fu 676; Ph 399; Russell 2353.*
unidentata *(Dryand.) E. Wimm.* subsp. intermedia *P.B. Phillipson Ph 145, 492, 498, 1474.*
8696 Grammatotheca bergiana *(Cham.) Presl* (var. not determined) *Fu 685; Fu & Ph 13, 119; Gi 1316; Ph 154, 1210.*
8699 Laurentia arabidea *(Presl) A. DC. Fu & Ph 9, 348.*

ASTERACEAE
8751 Vernonia
capensis *(Houtt.) Druce Gi 1130.*
dregeana *Sch. Bip. Ph 1181.*
hirsuta *Sch. Bip.* var. hirsuta *Gi 1185.*
natalensis *Sch. Bip. Ph & Hu 81.*
8818 Mikania cordata *(Burm. f.) B.L. Robinson Gi 916, 917.*
8866 Dichrocephala integrifolia *(L. f.) Kuntze Ph 1252.*
8900 Aster bakerianus *Burtt Davy ex C.A. Sm. Fu & Ph 74; GR 3434, 3526; Gi 274, 1131; Ph 101.*
8919 Felicia
filifolia *(Vent.) Burtt Davy* subsp. filifolia *Br 84; Fu & Ph 278; Tu 93, 96, 107, 110, 111, 112, 115.*
muricata *(Thunb.) Nees* subsp. muricata *Fu & Ph 338.*
quinquelobus *(Klatt) Grau Gi 1129, 1189.*
rosulata *Yeo Br 99; Ph 431.*
8921 Microglossa mespilifolia *(Less.) B.L. Robinson Gi 526.*
8925 Nidorella
auriculata *DC. Fu & Ph 227; Gi 389, 438, 1303, 1579.*
undulata *(Thunb.) Sond. ex Harv. Fu & Ph 43.*
sp. *Ph 1239.*
8926 Conyza
pinnata *(L. f.) Kuntze Fu & Ph 35; Gi 1277.*
scabrida *DC. Gi 390; Ph 140; Tu 181.*
sumatrensis *(Retz.) E.H. Walker Br 35, 39; GR 3013; Ph 810.*
8930 Chrysocoma tenuifolia *Berg. Ph 816; Tu 97, 113, 116, 146.*
8936 Brachylaena elliptica *(Thunb.) DC. Gi 977; Tu 174, 177.*
8949 Denekia capensis *Thunb. Fu 757; Fu & Ph 5, 127, 161.*
8992 Gnaphalium
austroafricanum *Hilliard*, Amatola Mts (Hilliard 1983: 20).
capense *Hilliard*, Amatola Mts (Hilliard 1983: 24).
coarctatum *Willd. Gi 140; Ph 501, 927.*
confine *Harv. Ph 1485.*
vestitum *Thunb. Gi s.n.*
8992b Troglophyton capillaceum *(Thunb.) Hilliard & Burtt* subsp. diffusum *(DC.) Hilliard Ph 1341.*
8992d Plecostachys polifolia *(Thunb.) Hilliard & Burtt Ph 510, 942.*
8992e Pseudognaphalium
luteo-album *(L.) Hilliard & Burtt GR 3138; Ph 505.*
undulatum *(L.) Hilliard & Burtt Br 03, 06, 31.*
9006 Helichrysum
adenocarpum *DC.* subsp. adenocarpum *Br 44; Fu 718; Gi 504, s.n.*
allioides *Less.*, Amatola Mts (Hilliard 1983: 239).
alticolum *H. Bol. Ph 822, 1063.*
anomalum *Less. Fu & Ph 279, 298; GR 3465, 3542; McGillivray 39; Ph 540.*
appendiculatum *(L. f.) Less. Fu & Ph 15; GR 3442; Gi 1148, 1187, 1256; Ph 94, 509; Ph & Hu 68.*
argyrophyllum *DC. Fu 675; Fu & Ph 240; Gi 442, s.n.; Ph 235; Zwane 101.*
asperum *(Thunb.) Hilliard & Burtt* var. appressifolium *(Moeser) Hilliard Ph 93, 1020.*
aureonitens *Sch. Bip. Br 07, 89, 122, 146; Fu & Ph 64.*
aureum *(Houtt.) Merrill* var. aureum *Br 83, 117; Gi 382, 1128, 1254; Ph 946.*
bellidiastrum *Moeser Ph & Hu 3.*
cephalodeum *DC. GR 3528; Ph 811, 1096.*
cymosum *(L.) D. Don* subsp. cymosum *Gi 439; Ph 103; Tu 195.*
dasycephalum *Hoffm. Fu & Ph 237.*
ecklonis *Sond. Fu & Ph 153; GR 3451; Robinson s.n.*
epapposum *H. Bol.*, Amatola Mts (Hilliard 1983: 74).
felinum *Less. GR 3486; Gi 1127; Ph 416; Robinson s.n.*
foetidum *(L.) Moench Br 08, 41, 94; Fu & Ph 232; GR 3144, 3503; Gi 276, 379, 1350; Ph 813* (Involucral bracts cream-coloured).
glomeratum *Klatt Br 36; Gi s.n.; Ph 808, 815.*
grandibracteatum *M.D. Henderson GR 3463; Gi 149; Ph 991; Robinson s.n.*
griseolanatum *Hilliard Fu & Ph 19, 37, 236; Gi 3532.*
herbaceum *(Andr.) Sweet Gi 1242; Ph 1017.*
intricatum *DC. Fu 689, 695.*
isolepis *H. Bol.*, Gaika's Kop, *Hilliard & Burtt 18791* (E, NU) (Hilliard & Burtt unpublished data).
krebsianum *Less. Fu* et al. *26; Gi 1255.*
miconiifolium *DC. Br 165; Fu & Ph 145.*
mixtum *(Kuntze) Moeser* var. mixtum *Br 164; Fu* et al. *24; Fu & Ph 219; GR 3459; Gi 1258.*
montis-cati *Hilliard Ph 420.*
mundtii *Harv. Fu* et al. *33; Gi 737.*
nudifolium *(L.) Less. Br 120; Fu* et al. *22; Fu & Ph 301, 302; GR 1324; Ph 538, 541, 1177.*
odoratissimum *(L.) Sweet Fu & Ph 111, 243; GR 3478; Gi s.n.; Ph 809, 1095.*
oxyphyllum *DC. Gi 1192.*
pallidum *DC. Fu* et al. *21; Fu & Ph 148.*
pedunculatum *DC. Ph 100.*

petiolare *Hilliard & Burtt Gi 1147; Tu 196, 242; Zwane 105.*
pilosellum *(L. f.) Less. Br 114, 129; Fu & Ph 325; GR 3439; Ph 990; Robinson s.n.*
platypterum *DC. Ph 823, 1070.*
psilolepis *Harv. Fu* et al. *23; Ph 149.*
rugulosum *Less. Br 04, 32, 112; Fu & Ph 62; GR 3475; Gi 1132.*
sessile *DC. Gi 374; Ph & Hu 32.*
simillimum *DC. Br 14, 37, 183; Fu* et al. *19; Gi 1311; Ph 543.*
spiralepis *Hilliard & Burtt Br 128; Fu* et al. *57; Fu & Ph 154; GR 3458, 3530; Gi 1259.*
splendidum *(Thunb.) Less. Fu & Ph 113; GR 3539; Russell 2341; Tu 101, 109, 247.*
subglomeratum *Less. Gi 1447, s.n.*
tenax *M.D. Henderson* var. tenax *Br 11; Fu & Ph 314; GR 3541; Gi 144; Robinson s.n.*
trilineatum *DC. Ph 867, 1062.*
umbraculigerum *Less. Fu* et al. *27; GR 3543; Gi 448, 1076, 1257; Ph 961, 1224.*
xerochrysum *DC. Gi 505; Ph 735.*
zeyheri *Less. Fu & Ph 277.*
sp. aff. H. mollifolium *Hilliard Ph & Hu 144.*

9037 Stoebe
vulgaris *Levyns* (S. plumosa sensu Story 1952: 98) *GR 3460; Gi s.n.; Ph 539; Tu 98, 108, 114, 256.*
sp. aff. S. vulgaris (S. cinerea sensu Story 1952: 98) *Fu & Ph 218; Gi 145; Tu 220, 223.*

9041 Elytropappus rhinocerotis *(L. f.) Less.*, between Chatha and Dontsa Forest Stations (Story 1952: 153).

9043 Metalasia muricata *(L.) D. Don Fu & Ph 34; Ph 326; Tu 266.*

9050 Relhania
pungens *L'Hérit.* subsp. angustifolia *(DC.) Bremer Fu & Ph 33.*
pungens *L'Hérit.* subsp. pungens *Gi 372, 1323.*

9052 Leysera gnaphalodes *(L.) L. Fu & Ph 52; Ph 542.*

9053 Macowania revoluta *Oliv. Gi 72; Tu 225, 227.*

9055 Athrixia
fontana *Macowan Fu & Ph 23.*
phylicoides *DC. Fu & Ph 304; Gi s.n.*

9058 Arrowsmithia styphelioides *DC. Fu & Ph 36; Gi 148, 212; McGillivray 43.*

9059 Printzia
huttonii *Harv. Gi 35, 385; Ph 765.*
pyrifolia *Less. Gi 1015; Ph 560.*

9078 Pulicaria scabra *(Thunb.) Druce Ph 1090.*
9155 Zinnia peruviana *(L.) L. Ph 1329.*
9311 Tagetes minuta *L. McGillivray 44; Tu 104.*
9320 Eriocephalus tenuifolius *DC. Ph 890.*
9321 Lasiospermum bipinnatum *(Thunb.) Druce Fu & Ph 51.*
9326 Athanasia dregeana *(DC.) Harv. Russell 2352; Ph 1055, 1072.*

9339 Matricaria
nigellifolia *DC.* var. tenuior *DC. Gi 1087; Ph 153.*
nigellifolia *DC.* var. nigellifolia *GR 4032.*

9340 Lepidostephium
asteroides *(H. Bol. & Schltr.) Kroner Gi s.n.*
denticulatum *Oliv. Fu & Ph 55; GR 3506; Gi 1180.*

9351 Cotula
heterocarpa *DC. Fu & Ph 10, 329; GR 3090, 3141, 3448, 3511; Ph 155.*
hispida *(DC.) Harv. GR 3512.*

9356 Schistostephium
crataegifolium *(DC.) Fenzl ex Harv. Ph 1071.*
flabelliforme *Less. Gi 474, 890, 1453.*
hippiifolium *(DC.) Hutch. Gi 43, 89, 1446; Tu 263.*

9358 Artemisia afra *Jacq. ex Willd. Fu & Ph 293; Gi 828; Tu 152, 163.*
9364 Gymnopentzia bifurcata *Benth. Ph 1351.*

9366 Pentzia
cooperi *Harv. Ph 819; Tu 130, 132.*
sp. *Ph 1196.*

9406 Cineraria
albicans *N.E. Br. Ph 814, 1092.*
sp. *Ph & Hu 156.*
aspera *Thunb. Ph 818.*
deltoidea *Sond. Gi 1274, 1297; Ph & Hu 115.*
sp. aff. C. geraniifolia *DC.* (C. geraniifolia sensu Hilliard 1977: 384) *Gi s.n.; Ph 1056, 1276, 1322.*

9411 Senecio
achilleifolius *DC. Ph 1292; Ph & Hu 24.*
adnatus *DC.*, Hogsback, *Hilliard & Burtt 10939* (E, NU) (Hilliard & Burtt unpublished data).
affinis *DC. Ph 1022.*
albanensis *DC.* var. doroniciflorus *(DC.) Harv. Ph 1215.*
asperulus *DC. Br 95; Fu & Ph 324.*
barbatus *DC. Br 143; Ph 1167.*
brevidentatus *M.D. Henderson Fu & Ph 151; GR 3450; Ph 1156, 1159; Ph & Hu 104.*
cathcartensis *Hoffm.* Discoid: *Pu 1222.* Rayed: *Fu & Ph 150; Ph 1260.*
caudatus *DC.*, Amatolas (Hilliard 1977: 467).
cissampelinus *(DC.) Sch. Bip.*, Amatolas (Hilliard 1977: 500).
coronatus *(Thunb.) Harv. Fu & Ph 90; Ph & Hu 84.*
decurrens *DC. Ph & Hu 108.*
deltoideus *Less. Ph 1480.*
digitalifolius *DC. Ph 1176.*
erubescens *Ait.* var crepidifolius *DC.*, Amatola Mts (Hilliard 1977: 422).
glaberrimus *DC. Gi s.n.; GR 3433; Ph 985; Ph & Hu 46, 82.*
gramineus *Harv. GR 3434, 3436; Ph 997.*
heliopsis *Hilliard & Burtt Gi s.n.*
hygrophilus *R.A. Dyer & C.A. Sm. Ph 947, 1175.*
hypochoerideus *DC. Ph & Hu 155.*
inaequidens *DC. Gi 866.*
isatideus *DC. Ph 800, 1023, 1174.*
juniperinus *L. f.* var. epitrachys *(DC.) Harv. Ph & Hu 27; Tu 90, 99, 105, 145, 150.*
lanceus *Ait. Ph 1321.*
latifolius *DC. Ph & Hu 106.*
lygodes *Hiern Gi s.n.; Ph 1091.*
macowaniana *Hilliard Ph & Hu 13.*
macrocephalus *DC. Fu & Ph 327; Ph 911; Robinson s.n.*; see also S. speciosus.
mikanioides *Otto ex Harv. Ph 1481.*
napifolius *Macowan Gi 1168.*
othonniflorus *DC. Ph 983; Ph & Hu 45.*
oxyodontus *DC. Gi 1093, 1263, 1521; Ph 1099; Tu 182.*
oxyriifolius *DC. Ph 1012; Ph & Hu 75.*
polyodon *DC.* var. polyodon *Fu & Ph 206.*
polyodon *DC.* var. subglaber *(Kuntze) Hilliard & Burtt Br 96; Fu & Ph 15, 93, 318; Gi 1267, 1336.*
pterophorus *DC. GR 3488; Gi 399.*
purpureus *L. Gi 1171; Ph & Hu 113.*
quinquelobus *(Thunb.) DC. Gi 1580.*
radicans *(L. f.) Sch. Bip. Ph 1484.*
retrorsus *DC. Ph 1171.*
serratuloides *DC.* var. gracilis *Harv. Fu 687; Fu & Ph 198; Gi s.n.; Ph 1089.*
serratuloides *DC.* var. serratuloides *Ph 1467, 1493.*
speciosus *Willd. Ph 1204* (This collection consists of a series of plants linking S. speciosus with S. macrocephalus), *1466.*
striatifolius *DC. Ph & Hu 105.*
subcoriaceus *Schltr. Br 85; Gi s.n. Ph 910.*
tamoides *DC. Gi 387; Nete 22; Tyibilika 45.*
sp. aff. S. cathcartensis *Hoffm. Ph & Hu 88.*
sp. aff. S. glutinosus *Thunb. Br 79, 119; Ph 339, 1143.*
sp. aff. S. hastatus *L. Fu & Ph 105, 326; Ph 982, 1069; Ph & Hu 15.*
sp. aff. S. speciosus (sensu Hilliard 1977: 432). Discoid: *Fu & Ph 360; GR 3427, 3520; Gi 1302; Ph 1009; Ph & Hu 78.* Rayed: *GR 3424; Gi 865, 1023, 1089, 1184, 1339, s.n.; Ph 1076, 1206; Ph & Hu 49, 109, 154; Robinson s.n.*

9417 Euryops
chrysanthemoides *(DC.) B. Nord.*, 1–2 miles along road to Ghulu Kop, Keiskamma Hoek, *Wells 3185* (GRA, PRE) (Nordenstam 1968: 368).
ciliatus *B. Nord. Ph 802, 827.*
dyeri *Hutch. Ph & Hu 19.*
galpinii *H. Bol. Ph 792.*
spathaceus *DC. Tu 257, 258, 261, 264.*
9420 Othonna sp. (possibly O. natalensis *Sch. Bip.*), Geju Mountain (Story 1952: 156, as O. amplexicaulis).
9426 Garuleum sonchifolium *(DC.) T. Norl. Gi g838; Ph 874.*
9427 Osteospermum
caulescens *Harv. GR 3425; Gi 150.*
grandidentatum *DC. Gi 66, 380, 451, 1176.*
9427b Chrysanthemoides monilifera *(L.) T. Norl.* subsp. pisifera *(L.) T. Norl. Gi 62, 393, 395, g846; Tu 198, 230, 243.*
9431 Ursinia
nana *DC.* subsp. nana *Ph 1494.*
tenuiloba *DC. GR 3432; Ph 1158; Robinson s.n.*
9432 Arctotis arctotoides *(L. f.) Hoffm. Fu & Ph 47; Ph 817, 1490.*
9432 Haplocarpha
nervosa *(Thunb.) Beauv. Br 121; Fu & Ph 50, 53; Gi 63, 436.*
scaposa *Harv. Br 124, 141; Fu & Ph 66; GR 3403; Gi 1193; Ph 252.*
9434 Gazania
krebsiana *Less.* subsp. krebsiana, Hogsback, *Rattray 108* (PRE) (Roessler 1959: 403).
linearis *(Thunb.) Druce* var. linearis *Fu & Ph 280.*
9438 Berkheya
acanthopoda *(DC.) Roessl.*, Dontsa Pass, *Acocks 9581* (M, PRE) (Roessler 1959: 256).
bipinnatifida *(Harv.) Roessl.* subsp. bipinnatifida *Ph 834.*
buphthalmoides *(DC.) Schltr. Ph 1004.*
carduoides *(Less.) Hutch. Ph 1075.*
decurrens *(Thunb.) Willd. Ph 1313.*
onopordifolia *(DC.) Hoffm. ex Burtt Davy* var. onopordifolia *Ph 1093.*
purpurea *(DC.) Mast. GR 3534.*
rhapontica *(DC.) Hutch. & Burtt Davy* subsp. aristosa *(DC.) Roessl.* var. aristosa *Fu & Ph 137, 247; GR 3462, 3510; Gi 1345.*
speciosa *(DC.) Hoffm.* subsp. speciosa *GR 3486a, 3491; Gi 1179.*
9461 Carduus tenuiflorus *Curtis GR 3406.*
9462 Cirsium vulgare *(Savi) Ten. GR 3146.*
9528 Gerbera
kraussii *Sch. Bip. Ph 1545.*
parva *N.E. Br. Ph 1010.*
9528b Piloselloides hirsuta *(Forssk.) C. Jeffrey Gi 135, 373, 383.*
9561 Tolpis capensis *(L.) Sch. Bip. Br 138; Gi 1231; Ph 980.*
9572 Hypochoeris radicata *L. Br 154; Fu & Ph 67; GR 3012, 3405, 3522; Ph 928.*
9592 Taraxacum officinale *Weber Ph 995.*
9595 Sonchus
asper *(L.) Hill* subsp. asper *Ph 1288.*
dregeanus *DC. Ph 974, 975; Ph & Hu 90.*
oleraceus *L. Ph 919, 929, 1026.*
wilmsii *R.E. Fries Ph 1173.*
9596 Lactuca
capensis *Thunb. Ph & Hu 94.*
serriola *L. Ph 1027.*
tysonii *(Phill.) C. Jeffrey Ph & Hu 79.*
9605 Crepis hypochoeridea *(DC.) Thell. Ph 973.*

Bothalia 17,2: 257–259 (1987)

Miscellaneous notes

VARIOUS AUTHORS

CHROMOSOME STUDIES ON AFRICAN PLANTS. 5.

The presentation of chromosome numbers in this report conforms with the format described in the first publications in this series (Spies & Du Plessis 1986a & b, 1987; Spies & Jonker 1987).

POACEAE

Aristideae

Aristida adscensionis L. subsp. *guineensis* (Trin. & Rupr.) Henr.: **n = 33.**

CAPE. — 2917 (Springbok): 71 km from Port Nolloth to Steinkopf (–AD), *Spies 2828.*

Eragrostideae

Fingerhuthia africana Lehm.: **n = 20.**

CAPE. — 2924 (Hopetown): 16 km from Griekwastad to Kimberley (–CD), *Spies 2678.*

Eragrostis echinochloidea Stapf: **n = 20, 30.**

CAPE. — 2822 (Glen Lyon): 93 km from Groblershoop to Kimberley (–DC), *Spies 2869* (n = 30). 2823 (Griekwastad): 16 km from Griekwastad to Kimberley (–CD), *Spies 2887* (n = 20). 2924 (Hopetown): 17 km from Heuningneskloof to Hopetown (–AD), *Spies 2691* (n = 20).

Eragrostis lehmanniana Nees: **n = 20.**

CAPE. — 2823 (Griekwastad): 123 km from Groblershoop to Kimberley (–CC), *Spies 2883.*

Eragrostis × *pseud-obtusa* De Winter: **n = 20, 40.**

CAPE. — 2822 (Glen Lyon); 93 km from Groblershoop to Kimberley (–DC), *Spies 2870* (n = 20). 2923 (Douglas): 65 km from Hopetown to Strydenburg (–DC), *Spies 2713* (n = 40).

Cynodonteae

Chloris virgata Swartz: **n = 20.**

CAPE. — 2924 (Hopetown): 17 km from Heuningneskloof to Hopetown (–AD), *Spies 2679.*

Andropogoneae

Bothriochloa insculpta (A. Rich.) A. Camus: **n = ~60.**

TRANSVAAL. — 2430 (Pilgrim's Rest): 23 km from Boshoek to Olifantshoek (–CD), *Spies 1543.*

Ischaemum afrum (J. F. Gmel.) Dandy: **n = 10.**

TRANSVAAL. — 2428 (Nylstroom): 10 km from Warmbaths to Pretoria (–CD), *Spies 2048.* 2528 (Pretoria): near Turfpan (–AB), *Spies 2053.*

Ischaemum fasciculatum Brongn.: **n = 10.**

TRANSVAAL. — 2528 (Pretoria): near Turfpan (–AB), *Spies 2052.*

Sehima galpinii Stent: **n = 40.**

TRANSVAAL. — 2528 (Pretoria): near Turfpan (–AB), *Spies 2056.*

Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy: **n = 10, 20.**

TRANSVAAL. — 2528 (Pretoria): 35 km from Warmbaths to Pretoria (–AB), *Spies 2044* (n = 10); near De Tweedespruit turnoff on road between Cullinan and Sybrandskraal (–DA), *Spies 2109* (n = 20).

Cymbopogon validus (Stapf) Stapf ex Burtt Davy: **n = 10.**

TRANSVAAL. — 2528 (Pretoria): 1 km from Cullinan to Pretoria (–DA), *Spies 2093.*

Schizachyrium sanguineum (Retz.) Alst.: **n = 20.**

TRANSVAAL. — 2528 (Pretoria): near Donkerhoek (–CD), *Spies 2070.*

Hyparrhenia filipendula (Hochst.) Stapf var. *pilosa* (Hochst.) Stapf: **n = 10, 20.**

TRANSVAAL. — 2528 (Pretoria): near Elands River on road between Cullinan and Sybrandskraal (–DA), *Spies 2100* (n = 10); near Klipspruit (–DA), *Spies 2121* (n = 20).

Hyparrhenia tamba (Steud.) Stapf: **n = 20.**

TRANSVAAL. — 2528 (Pretoria): near Sphinx Station (–CA), *Spies 2019.*

Heteropogon contortus (L.) Roem. & Schult.: **n = 20, 28.**

TRANSVAAL. — 2528 (Pretoria): 1 km from Cullinan to Pretoria (–DA), *Spies 2097* (n = 28). 2530 (Lydenburg): near Goede Hoop (–AC), *Spies 1581a* (n = 20).

Paniceae

Digitaria monodactyla (Nees) Stapf: **n = 9.**

TRANSVAAL. -- 2430 (Pilgrim's Rest): Blyderivierspoort Nature Reserve (–DB), *Spies 1427.*

Urochloa brachyura (Hack.) Stapf: **n = 18.**

TRANSVAAL. — 2528 (Pretoria): near Sphinx Station (–CA), *Spies 2013.*

Urochloa mosambicensis (Hack.) Dandy: **n = 14.**

TRANSVAAL. — 2528 (Pretoria): 35 km from Warmbaths to Pretoria (–AB), *Spies 2040.*

Panicum coloratum L. var. *coloratum:* **n = 9.**

TRANSVAAL. — 2528 (Pretoria): 35 km from Warmbaths to Pretoria (–AB), *Spies 2036.*

Brachiaria brizantha (A. Rich.) Stapf: **n = 27.**

TRANSVAAL. — 2528 (Pretoria): near Klipspruit (–DA), *Spies 2120.*

Setaria megaphylla (Steud.) Dur. & Schinz: **n = 27.**

TRANSVAAL. — 2528 (Pretoria): near Pienaars River on road between Pretoria and Bronkhorstspruit (–DA), *Spies 2065.*

Cenchrus ciliaris L.: **n = 16.**

TRANSVAAL. — 2528 (Pretoria): near Pienaars River on road between Pretoria and Warmbaths (–AD), *Spies 2034.*

Rhynchelytrum repens (Willd.) C. E. Hubb.: **n = 18.**

TRANSVAAL. — 2530 (Lydenburg): 41 km from Lydenburg to Roossenekal (–AA), *Spies 1591*; 15 km from Dullstroom to Goede Hoop (–AC), *Spies 1448a.*

Agrostideae

Agrostis lachnantha Nees var. *lachnantha:* **n = 28.**

TRANSVAAL. — 2528 (Pretoria): near Pienaars River on road between Pretoria and Bronkhorstspruit (–DA), *Spies 2058.*

Aveneae

Koeleria capensis (Steud.) Nees: **n = 14.**

TRANSVAAL. — 2530 (Lydenburg): near Frischgewaagd (–AC), *Spies 1565a.*

DISCUSSION

The basic chromosome numbers presented in this article conform, in most instances, to published results for the same species, or for other species of the genus (Darlington & Wylie 1955; Ornduff 1967–1969; Fedorov 1969; Moore, R. J. 1970–1977; Moore, D. M. 1982; Goldblatt 1981–1985).

Deviations from the expected chromosome numbers were observed in three species. The somatic chromosome number of 2n = 28 observed for *Spies 2040, Urochloa mosambicensis,* represents a basic chromosome number of seven, contrary to the expected number of nine for the tribe Paniceae. Various deviations from the expected basic number of nine seem to dominate chromosome counts in the genus *Urochloa.* Somatic chromosome numbers based on 7, 8, 9, 10, 12, 13 and 23 have been reported, with the numbers based on seven and nine being the most frequent (Darlington & Wylie 1955; Ornduff 1967–1969; Fedorov 1969; Moore, R. J. 1970–1977; Moore, D. M. 1982; Goldblatt 1981–1985). The same variation is observed in *U. mosambicensis,* where reported chromosome numbers include somatic numbers of 14 (Davidse, Hoshino & Simon 1986), 28 (Nath & Swaminathan 1957; Raman, Chandrasekharan & Krishnaswami 1959; Nath, Swaminathan & Mehra 1970; current study), 30 (De Wet & Anderson 1956), 40 (Pritchard 1970) and 42 (Moffett & Hurcombe 1949). This study indicated that all meiotic stages were normal and, therefore, aneuploidy is not expected in plants with a basic chromosome number of seven.

The second specimen with a chromosome number deviating from the expected number is a *Cenchrus ciliaris* specimen, *Spies 2034,* with 2n = 32. However, *C. ciliaris* is a known aneuploid species and somatic chromosome numbers of 29, 32, 34, 36, 38, 40, 42, 44, 45, 52, 54, 56 and 78 have been described (Donald 1953; Darlington & Wylie 1955; Jogindernath & Swaminathan 1957; Patil, Vohra & Joshi 1961; Ornduff 1967–1969; Fedorov 1969; Jagannath & Raman 1974; Moore, R. J. 1970–1977; Moore, D. M. 1982; Goldblatt 1981–1985; Spies and Du Plessis 1986b & 1987). This aneuploid series of chromosome numbers is not restricted to this species. The genus *Cenchrus* has chromosome numbers of 30, 32, 34, 35, 36, 37, 38, 40, 42, 44, 45, 52, 54, 56, 66, 68, 70 and 78, with 34 and 36 being the most common (Darlington & Wylie 1955; Ornduff 1967–1969; Fedorov 1969; Moore, R. J. 1970–1977; Moore, D. M. 1982; Goldblatt 1981–1985).

The third species with a chromosome number deviating from the expected number is a *Heteropogon contortus* specimen, *Spies 2097,* with a somatic chromosome number of 56. This is the second *H. contortus* specimen with an aneuploid chromosome number observed during this series. The previous specimen had a somatic number of 46 (Spies & Du Plessis 1986a). Further investigations into the extent of aneuploidy and modes of reproduction of such plants are planned.

Meiotic chromosome pairing was abnormal in a significant number of the specimens studied. Abnormalities were observed in the following species:

1, *Ischaemum afrum,* where nil to four chromosome laggards were observed during anaphase I. Micronuclei were observed during telophase II in the same specimen, *Spies 2048*;

2, *Hyparrhenia filipendula* var. *pilosa, Spies 2100,* which is a diploid specimen (2n = 20), has a very abnormal meiosis. Between 50% and 60% of metaphase I cells have at least one univalent. The number of univalents varied from nil to four and the chromosome configurations varied from $4_{I}\ 8_{II}$ to $1_{1}\ 8_{II}\ 1_{III}$. During anaphase I one to four univalents per cell were present. In the tetraploid (2n = 40) specimen, *Spies 2121,* six univalents were observed in each cell. However, the occurrence of these univalents did not result in any laggards or any other abnormalities;

3, *Hyparrhenia tamba.* Meiotic chromosome behaviour was very abnormal in the tetraploid (2n = 40) specimen studied, *Spies 2019.* During metaphase I chromosome configurations varied from 20_{II} to $6_{II}\ 7_{IV}$, with a $14_{II}\ 3_{IV}$ configuration being the most frequent one. The high multivalent frequency indicates a possible autoploid origin for this specimen. However, an insufficient number of cells have been studied to determine the type of ploidy origin in this specimen according to the available statistical methods (Kimber & Alonso 1981; Spies 1984). The high frequency of multivalent formation resulted in abnormal chromosome segregation during anaphase I where it varied from normal to a 16:24 segregation;

4, *Heteropogon contortus.* The aneuploid (2n = 56) specimen, *Spies 2097,* had two to four univalents during metaphase I, as well as up to four laggards during anaphase I. Chromosome configurations during diakineses varied from 28_{II} to $6_{1}\ 25_{II}$;

5, *Digitaria monodactyla.* This is another example of abnormal chromosome behaviour in a diploid (2n = 18) specimen. Occasionally up to three laggards were observed during anaphase I.

Another interesting observation during this study was the fact that a *Bothriochloa insculpta* specimen, *Spies 1543,* with a very high chromosome number (2n = ~120), had a very normal meiosis with no abnormalities.

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J. J. SPIES* and H. DU PLESSIS*

* Botanical Research Institute, Department of Agriculture and Water Supply, Private Bag X101, Pretoria 0001, RSA.

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OBITUARY

ROLF DAHLGREN (1932–1987)

The botanical world was shocked and dismayed at the news of the tragic death of the eminent Swedish botanist, Prof. Rolf Dahlgren, in a traffic accident on 14 February, 1987. A systematic botanist of international stature, Rolf Dahlgren belongs to the illustrious group of Swedish natural scientists, which includes Linnaeus himself and his students Thunberg and Sparrman, who were crucial to the course of botany in southern Africa.

Rolf Martin Teodor Dahlgren (Figure 1) was born in Örebro, Sweden on 7 July 1932, the son of Rudolf Dahlgren, a pharmacist, and Greta Dahlgren of Helsingborg. After matriculating in Kristianstad in 1951, he registered at the University of Lund in August of that year. Subjects he studied included botany, zoology, genetics and chemistry. He was awarded the following degrees from the University of Lund: Fil. Kand. (1955), Fil. Lic. (1959), Fil. Mag. (1959) and Fil. Dr. (1964). In December 1963, he defended his doctoral thesis entitled *Studies on* Aspalathus *and some related genera in South Africa.*

He worked at the Institute of Systematic Botany of the University of Lund from 1953 to 1973, first as Amanuensis, later as Assistant Lecturer (1960–1963), and then as Docent in Systematic Botany. During the year 1971–1972 he was Acting Professor of Botany. In June 1973 he was appointed Professor at the Botanical Museum of the University of Copenhagen, Denmark. Here he worked until his death, commuting daily between his home in Lund (Sweden) and Copenhagen.

Rolf Dahlgren loved southern Africa, its flora and its peoples. He took a special interest in the Cape Flora and wrote lasting and, in some instances, monumental contributions on some of its largest and most difficult groups. His involvement with the southern African flora was inspired by the tutelage and influence of Profs H. Weimarck and T. Norlindh, who were members of Prof. T. C. E. Fries's extensive botanical expedition to southern Africa in 1930–1931.

The field work for his monographic studies on *Aspalathus* and other Cape taxa was done during two extended visits to this country, lasting in total for about 15 months. On the first visit (July 1956 to February 1957) he was accompanied by Bo Peterson and on the second (August 1965 to February 1966) by Arne Strid (Figure 2). During these visits he was stationed mainly at the Bolus Herbarium and the National Botanic Garden, Kirstenbosch, respectively. Most of his field work, in which he was greatly assisted by Elsie Esterhuysen of the Bolus Herbarium, was done in the Cape Floristic Region. On the second visit he transplanted numerous collections of seedlings of *Aspalathus* (well over 150 species) and other leguminous genera from the veld to the nursery of the National Botanic Garden, Kirstenbosch. These were used for his studies on chromosome numbers in the genus. Although still rounding off his work on *Aspalathus,* Rolf had by now also turned his attention to the Penaeaceae, one of the Cape endemic families. This involvement with the Penaeaceae seems to mark his move away from species monographs and the beginning of his wider interest in the relationships between families of flowering plants. During this period of work in South Africa he received the Smuts Memorial Fellowship in Botany which was jointly administered by the University of Cape Town and the National Botanic Gardens.

The genus *Aspalathus,* which he chose for his doctoral thesis, is the largest genus of flowering plants endemic to southern Africa (almost 280 species). It is, next to *Erica,* the second largest genus of the Cape Flora, and besides being a taxonomically difficult group, shows many interesting features and evolutionary trends. One of the features elucidated in the numerous papers which he published on the genus, is the convergent evolution between *Aspalathus* and *Cliffortia* (Rosaceae). Rolf also researched the taxonomy and related aspects of various other southern African genera of the Fabaceae, including *Wiborgia, Lebeckia, Hypocalyptus and Lotononis.*

FIGURE 1. — Rolf Martin Teodor Dahlgren, 7 July 1932 – 14 February 1987.

FIGURE 2. — Rolf Dahlgren (on the left) and Arne Strid, collecting *Endonema lateriflora* (L.f.) Gilg (Penaeaceae) on Kanonkop, Riviersonderend Range, above Genadendal, 21 February 1966. Photo: J. P. Rourke.

The endemic family Penaeaceae was revised by him in a series of publications in which he described the new genus *Sonderothamnus*. Among other groups on which he wrote accounts, are the Cape endemic families Geissolomataceae and Retziaceae. Recently he produced a manuscript (with the present author) on the structures and relationships of families and isolated genera endemic to or centred in southern Africa.

His last visit to South Africa was during January/February 1982 when he was Visiting Scientist at the Department of Botany, University of Pretoria. At that time he also attended the AETFAT Congress in Pretoria and undertook a field excursion to northern and eastern Transvaal and Venda, (Figure 3) accompanied by Pieter Kok and the present author.

FIGURE 3. — Rolf Dahlgren with *Eulophia angolensis* (Reichb. f.) Summerh. (Orchidaceae), Magoebaskloof, north-eastern Transvaal, February 1982.

Rolf Dahlgren collected more than 5 000 numbers of herbarium specimens in southern Africa, mainly of *Aspalathus, Wiborgia* and Penaeaceae from the Cape but also including material from Natal, Transvaal and Zimbabwe. The majority of these are housed in LU (first set), BOL, GRA, NBG, PRE and PRU. During numerous botanical travels in other parts of the world he visited countries such as Morocco, Egypt, Sri Lanka, USA (California) and south-western Australia.

Rolf spent most of his spare time in the months before his death on revising and adapting his *Aspalathus* treatment for the *Flora of southern Africa* (FSA). Further field studies were required to help

FIGURE 4. — Rolf Dahlgren was also a gifted botanical artist. This illustration of different forms of *Aspalathus triquetra* Thunb. is one of 146 plates accompanying the recently submitted manuscript of his treatment of the genus for the *Flora of southern Africa*.

solve a number of uncertainties, and in 1985 he applied to the Department of Agriculture and Water Supply for a research fellowship to visit the country from August to November, 1986. The application was approved but, sadly, due to factors beyond the realm of science, he regretfully had to turn down the offer. As he put it in a letter written at the time '. . . I much regret that I cannot go to South Africa. I had looked forward so much to that'. In a letter of March, 1986 he stated '. . . I thought it (the *Aspalathus* manuscript) might as well be placed with the editorial group, so that it can be printed in due course (God only knows how long one will live and whether I would have time to work on that later on; so it was best to have it completed), but I have no illusions that it has to be published in the nearest future'. The manuscript of his monumental treatment was submitted in mid-1986. It consists of 596 typed pages, numerous distribution maps and 146 plates of line drawings, beautifully executed by Rolf himself (Figure 4). His input into *Aspalathus* is considerable: besides numerous infraspecific taxa and new combinations, he described no fewer than 90 new species.

Rolf has also made contributions of a more local interest to areas other than southern Africa. Together with Swedish colleagues he published accounts on *Eleocharis (Drawings of Scandinavian plants)*; the flora of northern Morocco (poor fen communities) and chromosome numbers for taxa in the Balearic Islands.

It was, however, Rolf's systematic studies on the families of angiosperms that brought him world fame and ensured reference to his contributions in all modern textbooks on plant systematics. After his appointment at the Botanical Museum in Copenhagen, his interest was focused mainly on angiosperm taxonomy and phylogeny on the higher levels — an interest surely awakened by his early and directive exposure to the marvels of the Cape Flora. In cooperation with colleagues he produced an outstanding Danish taxonomic textbook in four volumes entitled *Angiospermernes taxonomi* (1974–1976). This has appeared in a second revised edition (1980–1981). An outline of a new classification of the angiosperms was presented in 1975 (*Botaniska Notiser* 128). On the basis of extensive factual material, including evidence from macromorphology, anatomy, embryology, cytology, palynology, phytochemistry and various other disciplines, he was able to present a new, much revised classification in 1980 (*Botanical Journal of the Linnean Society* 80). A more recent version of this classification appeared in the proceedings of the symposium '*New evidence of relationships and modern systems of classification*' held during the 1981 International Botanical Congress in Sydney, and organized by Rolf and Prof. F. Ehrendorfer (*Nordic Journal of Botany* 3, 1983). Dahlgren's classification has gained wide support and is considered by many botanists to be the best yet developed. It has been used for the layout of botanical gardens in Hungary and West Germany and was presented in Chinese in 1985.

In 1976 Rolf started a major project on monocotyledons. This resulted in two monumental works *The Monocotyledons: a comparative study* (with H. T. Clifford 1982) and *The families of the Monocotyledons: structure, evolution and taxonomy* (with H. T. Clifford & P. Yeo 1985). These works are the most comprehensive treatments on monocotyledons available today and will, undoubtedly, become classics in this field. About the latter book Rolf wrote '. . . provocative, splitting (deliberately), but probably quite useful to the new thinking on evolution and taxonomy of monocots . . . taxonomic views will probably catch up with us at last'. Cladistics have only recently been applied in botany and Rolf came out strongly in favour of its application and underlying philosophies. In 1983 he published (with F. N. Rasmussen) a comprehensive cladistic evaluation of the monocotyledons (*Evolutionary Biology* 16). Included in the latter is a condensed and elegant introduction to the most important concepts of cladistics. Rolf's work on angiosperm evolution had immediate international impact and in later years he became one of the leading scientists in this field.

To illustrate his angiosperm system, he employed a two-dimensional cladogram in which the orders of angiosperms are represented as the transections of an imaginary phylogenetic tree. This diagram proved to be extremely useful to demonstrate the distribution of character states (*Plant Systematics and Evolution, Supplement* 1, 1977) and has since been used in various contributions by other botanists and chemists.

The continuous co-operation with chemists at the Technical University of Denmark resulted in a treatise on the distribution of iridoid compounds. This led to the re-interpretation of the relationships of various families and family complexes on the basis of chemical, embryological and other properties (several papers in *Botaniska Notiser)*. Most of these proposals have subsequently been supported. The distribution of various secondary metabolites in angiosperms was discussed in a 1981 paper (in, D. A. Young & S. Seigler, *Phytochemistry and angiosperm phylogeny)*. In 1982, at a protein-taxonomy symposium at Bayreuth, West Germany. Rolf gave a survey of the contribution of the last 30 years' serological research to angiosperm taxonomy (published in 1983 in U. Jensen & D. E. Fairbrothers, *Protein and nucleic acids in plant systematics)*.

At another Sydney symposium (1981), he presented (with R. F. Thorne) a major treatise on the circumscription, variation and relationships of the order Myrtales (*Annals of the Missouri Botanical Garden* 71,3,1984). One of his last Congress contributions was at the American Institute of Biological Sciences Meeting held at the University of Massachusetts, Amherst during August 1986. He delivered a paper in a symposium on the biology and relationships of Rhizophoraceae and Anisophyllaceae. In addition to participating in this symposium he also took part in another symposium at the conference: *Systematics and evolution of the monocotyledons.*

For the two year period 1967–1968, Rolf was editor of *Botaniska Notiser* and *Opera Botanica.* At the time of his death he was acting (together with P. Goldblatt) as managing editor for the monocotyle-

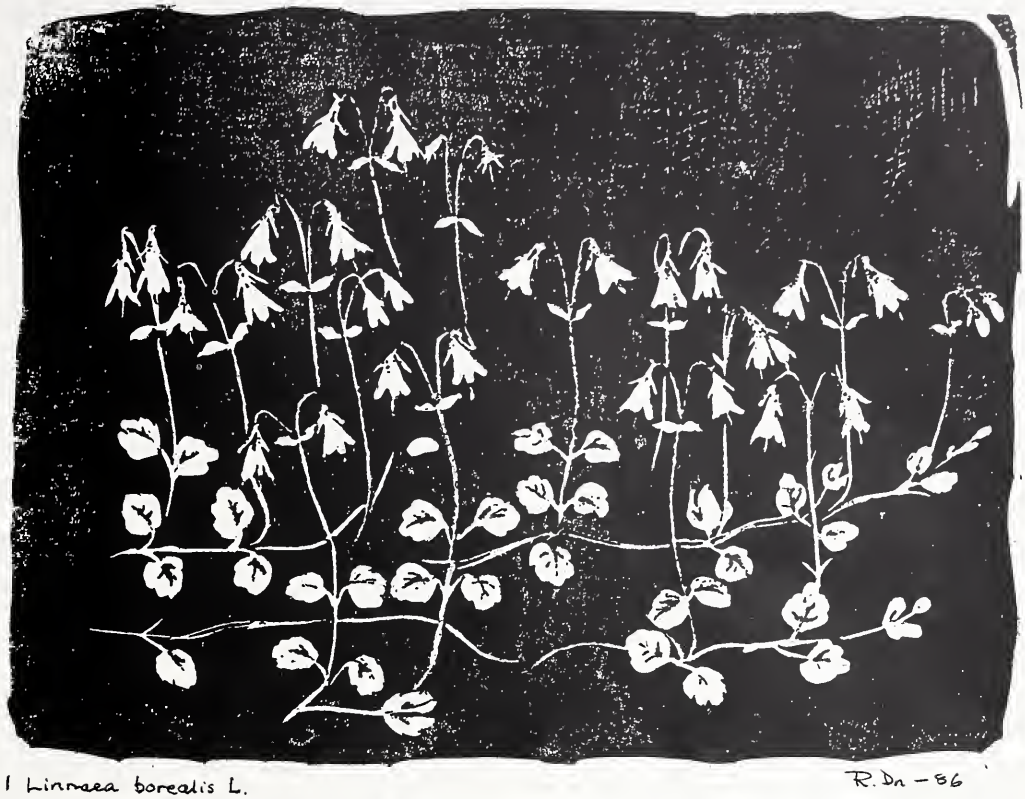

FIGURE 5. — For many years Rolf Dahlgren sent his self-made lino-printed Christmas cards to friends all over the world. This is the last one of December 1986.

don volume of the work *Families and genera of vascular plants* — a major project in which all higher plant families are to be elucidated from various aspects. Rolf has given lectures on invitation in several countries including the USA, South Africa, Australia, Germany, England and Scotland. He was a member of the Royal Physiographical Society (Lund), Det Kongelige Danske Videnskabernes Selskab, Copenhagen and many other societies and boards. He valued particularly having been elected to the Royal Swedish Academy of Science in 1986 — the same year that he was honoured with the prestigious Linnean Prize of the Royal Physiographical Society.

Rolf was an extremely friendly and accessible person endowed with great generosity and a fine sense of humour. He had very many friends and stimulated interest in young and old alike. He believed in co-operation and was always eager to send material to specialists for detailed study. He also believed in keeping regular contact with friends and colleagues. In this regard one may mention his self-made lino-printed Christmas cards (Figure 5) sent to friends all over the world — each a much valued piece of art. Rolf was one of those rare botanists with a grasp of flowering plant classification on a worldwide basis. His knowledge of the literature was of amazing depth and of an all-encompassing scope. During conversations with him one got the impression that he could discuss any plant group, no matter how obscure or rare. Yet he was extremely humble in his view of himself and his achievements. In his sympathetic way he tended to see only the best in everyone and destructive criticism and quarrelsomeness were not in his nature. He once wrote '. . . I wish I had been more stubborn and self-confident in the views I hold . . .'. Thanks to the hospitality of Rolf and his wife, Gertrud, also a botanist, many researchers from different parts of the world, including South Africa, had the privilege of staying with him at their friendly home.

It has been an exceptional experience and opportunity for those of us fortunate to have been acquainted with Rolf. With his death botany has lost a distinguished exponent and we have lost a dear colleague. He will be remembered with great affection and respect by his many friends. Rolf leaves behind his wife Gertrud, and their children Susanna, Helena and Fredrik.

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A. E. VAN WYK*

* Curator: Schweickerdt Herbarium, University of Pretoria, Pretoria 0002.

Bothalia 17,2: 267–268 (1987)

OBITUARY

JOHN FREDERICK VICARS PHILLIPS (1899–1987)

When Prof. John Phillips (Figure 1) of Blue Bird Farm, Hekpoort in the Transvaal, passed away early this year, a long, distinguished and fruitful career in ecology came to an end.

John Frederick Vicars Phillips (also known under his nickname Jaypee) was born in Grahamstown on 15 March 1899. After his initial education at Dale College in King William's Town he joined the Department of Forestry and received a bursary to Edinburgh University. He attended that university from 1919–1922 and obtained a B.Sc. degree with Forestry and Botany at Honours level. He was then appointed Research Officer by the South African Department of Forestry and stationed at Knysna where he was involved in ecological research and management of the indigenous forests until 1927. In that year he was awarded a D.Sc. degree by the University of Edinburgh for a thesis he presented on *Forest succession and ecology in the Knysna region.* It was published in 1931 as *Memoirs of the Botanical Survey of South Africa* No. 14.

He moved to Tanganyika [Tanzania] where he worked from 1927–1931 as ecologist and later as Deputy Director (Research) in the Department of Tsetse Fly Research. He was responsible for a very comprehensive programme on the ecology of the tsetse fly. Some of his staff members who co-operated in the programme obtained higher degrees on the publication of their findings.

In 1931 John Phillips returned to South Africa as Professor of Botany at the University of the Witwatersrand. At the time he was the youngest person ever to have held this title. A strong school of ecology was established through his endeavours and in 1933 he started the Frankenwald Research Station where pasture research workers, some from other countries, were trained. Among the students who worked with Phillips in those days were J. D. Scott, H. Gillman, Philip Glover and Oliver West, all of whom made names for themselves in the field of ecology.

After World War II he was instrumental in introducing two courses in soil conservation at the university. These were crash courses of three or four years for returned soldiers and were not available elsewhere. Some hundred-and-twenty ex-servicemen graduated from the course, with a B.Sc. degree in Soil Conservation. These men spread the conservation ideal in many parts of Africa and overseas.

Early in 1947 Phillips was asked to help with the Groundnut Scheme in Tanganyika which had been initiated by the colonial government in that country to provide oil for Britain. He did not accept, until in 1948 he was put under strong pressure to do so. His participation came too late to save the scheme, which was probably doomed in any case. The authorities, however, accepted his reports, drawn up in 1950, in which he recommended that the scheme should be reduced to a 'pilot' enterprise. From 1948–1951 Prof. Phillips also acted as Adviser to the Ministry of Food of the British Government in Tanganyika. In 1951 he was approached to act as Dean and to start a Faculty of Agriculture at the University of Ghana where he stayed until 1960. During this time he was also consultant on agricultural and forestry matters to the World Bank. In 1960 he went to Southern Rhodesia [Zimbabwe] to become Adviser to the Ministry of Agriculture until 1963.

His career then took him to Natal where he assumed duty as Senior Research Fellow for the Town and Regional Planning Commission of the province. His work there was published in Pietermaritzburg in 1973 as Report 19 of the Commission and entitled *The agricultural and related development of the Tugela Basin and its influent surrounds.* Since then much of the agricultural planning in the province has been based on his well known map of the bioclimatic regions of Natal which was included in the publication.

Furthermore Prof. Phillips was Honorary Visiting Professor in Applied Ecology at the University of Pennsylvania in 1966 and during a period in 1966–67 he headed a United Nations mission to the hill tribes of Thailand. After his retirement in the mid-seventies he still served as technical adviser on the rehabilitation of mine dumps and related matters to the Anglo American Corporation.

FIGURE. 1. — John Frederick Vicars Phillips (1899–1987).

In his career he was supported and encouraged by people such as General J. C. Smuts and Dr I. B. Pole Evans. He travelled the world and through his ecological research he made contact with scientists and policy-makers of many countries. His research led to numerous publications which deal mainly with the ecology of forests, grasslands and wooded savanna in subSaharan Africa, and the application of ecological principles to agricultural systems on this continent.

The biological specimens he collected in the Knysna vicinity and elsewhere in South Africa are housed in BOL, SAAS, NU, PRE and PREM. He also collected in the former Tanganyika, Ghana and Rhodesia when he was stationed there. His name is commemorated in *Morenoella phillipsii,* a fungus from Knysna.

Prof. Phillips was a Fellow of the Royal Society of Edinburgh, a Fellow of the Royal Society of South Africa and was President of the South African Association for the Advancement of Science in 1969. In the same year Rhodes University conferred an honorary D.Sc. degree on him.

He died at Hekpoort on 17 January 1987 after a long illness. Prof. J. D. Scott, a family friend, has fond memories of John Phillips: ‘he had an engaging personality, immense energy and drive, both physically and mentally. He had the ability to inspire not only students but colleagues and others with whom he came into contact.’ His daughter, Mrs Jean Paterson, refers in a letter written after his death, to ‘his terrific sense of humour and his kindness to animals and man’.

His passing away has left a void in the lives of his family, and his many friends and scientific associates, but he will long be remembered by those whose lives he touched.

EMSIE DU PLESSIS

Bothalia 17,2: 269–275 (1987)

New taxa, new records and name changes for southern African plants

G. E. GIBBS RUSSELL, C. REID, L. FISH, G. GERMISHUIZEN, M. VAN WYK, J. VAN ROOY and STAFF

Keywords: name changes, new records, new taxa, PRECIS, southern Africa

ABSTRACT

Alterations for the year 1986 to the inventory maintained in PRECIS are reported for bryophytes, pteridophytes and monocotyledons, and for a few dicotyledons. For the cryptogams and monocots there are 77 newly described species or infraspecific taxa, 27 names brought back into use, and nine species newly reported for southern Africa, resulting in 113 additions to the total list of species. Five species were removed because they were mistakenly recorded from the area. Seventy-five names have gone into synonymy, there are 52 new combinations, and there are 35 orthographic corrections, resulting in 237 alterations to the list of species. The total of 355 additions, deletions and alterations represents about 5% of the total species and infraspecific taxa for the cryptogams and monocots.

UITTREKSEL

Veranderings vir die jaar 1986 aan die lys wat in PRECIS gehou word, word van briofiete, pteridofiete en monokotiele, en van 'n paar dikotiele vermeld. By die kriptogame en monokotiele is daar 77 nuut-beskryfde spesies of infraspesifieke taksons, 27 name wat in gebruik teruggebring is en 9 spesies wat nuut aangeteken is in suidelike Afrika, wat gelei het tot 113 toevoegings tot die totale lys van spesies. Vyf spesies moes verwyder word omdat hulle verkeerdelik in die gebied aangeteken is. Vyf-en-sewentig name is in sinonimie geplaas, daar is 52 nuwe kombinasies en daar is 35 ortografiese regstellings, wat 237 wysigings aan die lys van spesies tot gevolg gehad het. Die totaal van 355 toevoegings, skrappings en wysigings verteenwoordig meer as 5% van die totale getal spesies en infraspesifieke taksons by die kriptogame en monokotiele.

INTRODUCTION

This is the third in this series that reports annual alterations to the complete inventory of southern African plants maintained in the computer system, PRECIS. The previous annual lists of changes were published in *Bothalia* 15: 757–759 (1985) and 16: 109–118 (1986) (Staff of the National Herbarium 1985, 1986). The format continues to be that of the *List of species of southern African plants, Edn 2, Part 1* (Gibbs Russell *et al.* 1985). The complete and up-to-date listing of names, literature and useful synonyms for all the 24 000 southern African plants is continuously maintained as part of PRECIS. Listings of the most recent treatment for any family or genus can be supplied by the Botanical Research Institute.

The majority of changes reported here apply only to cryptogams and monocots because changes for the dicotyledons to 30 June 1986 are included in the *List of species of southern African plants,* Edn 2, Part 2 (Gibbs Russell *et al.* 1987). However, a few changes for dicots published in the last half of 1986 are listed here.

Families and genera follow the order and numbering of the Englerian classification system, as given by Dyer (1975, 1976), and species are in alphabetical order. A name in current use appears in capital letters with its PRECIS number. Synonyms appear in lower case letters, and each synonym is entered twice, once indented below the name for which it is a synonym, and once in its alphabetical place in the genus. New collection records are indicated by quoting a specimen and its locality. Naturalized taxa are shown by an asterisk following the name.

The length of the list is again surprising to its compilers. During 1986 there were additions, deletions and alterations in about 5% of the names for cryptogams and monocots, compared to about 6% for 1985. Additions include 77 newly described species or infraspecific taxa, 27 names brought back into use that were not in previous lists, and nine species newly reported for southern Africa (all grasses, seven of them naturalized), giving a total of 113 additions to the list. Deletions include five pteridophyte species that were removed from the list because they had been mistakenly recorded from southern Africa. Alterations include 75 names that have been reduced to synonymy, 52 new combinatons, and 35 orthographic corrections, giving a total of 237 alterations to the list.

The effort necessary to evaluate and compile the changes, to implement them curatorially in herbaria, and to use them in conjunction with existing literature has been discussed previously (Staff of the National Herbarium 1986). At that time it was thought that the 1985 figure of 6% changes to the overall list for cryptogams and monocots was unusually high because of many alterations in Restionaceae (Linder 1985). Therefore, changes amounting to 5% of the list in a year, when there have been no revisions of large groups, is unexpected.

Each contributor is acknowledged at the name of the group or family for which he is responsible.

* Botanical Research Institute, Private Bag X101, Pretoria 0001.

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STAFF OF THE NATIONAL HERBARIUM 1986. New taxa, new records and name changes for southern African plants. *Bothalia* 16: 109–118.

BRYOPHYTA Contributed by J. van Rooy 1000

HEPATICAE

An up-to-date systematic arrangement of southern African liverwort genera in orders, families and subfamilies after Grolle (1983), which is essentially that of Schuster (1980), will be followed in future.
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2. Schuster, R.M. 1980. Syst. Assn. Special Vol. 14: 41-82.

PTERIDOPHYTA Contributed by C. Reid

SELAGINELLACEAE 30

30 -SELAGINELLA BEAUV.
5. SCHELPE & ANTHONY. 1986. FSA.
300 S. IMBRICATA (FORSSK.) SPRING EX DECNE.
(Note author correction)

ISOETACEAE 40

40 -ISOETES L.
5. SCHELPE & ANTHONY. 1986. FSA.
I. rhodesiana Alston = I. SCHWEINFURTHII
520 I. PERRIERIANA IVERSEN
(Note correct spelling)
550 I. SCHWEINFURTHII A. BR.
(=I. rhodesiana Alston) 5
720 I. TRANSVAALENSIS JERMY & SCHELPE
(Note author change)

OPHIOGLOSSACEAE 60

60 -OPHIOGLOSSUM L.
4. SCHELPE & ANTHONY. 1986. FSA.
400 O. POLYPHYLLUM A. BR. IN SEUB.
(Note author change)

OSMUNDACEAE 80

80 -OSMUNDA L.
4. SCHELPE & ANTHONY. 1986. FSA.
100 O. REGALIS L.
(=O. schelpei Bobrov) 4
(=O. transvaalensis Bobrov) 4
O. schelpei Bobrov = O. REGALIS
O. transvaalensis Bobrov = O. REGALIS

SCHIZAEACEAE 100

100 -ANEMIA SWARTZ
4. SCHELPE & ANTHONY. 1986. FSA.
200 A. SIMII TARDIEU
(Note author change)

MARSILEACEAE 190

190 -MARSILEA L.
4. LAUNERT. 1983-84. GARCIA DE ORTA 6: 119.
1000 M. NUBICA A. BR. VAR. GYMNOCARPA (LEPR. EX A. BR.) LAUNERT

AZOLLACEAE 200

200 -AZOLLA LAM.
4. ASHTON & WALMSLEY. 1984. BOT. J. LINN. SOC. 89: 239
A. nilotica Decne. ex Mett. does not occur in Southern Africa
300 A. PINNATA R. BR.

DENNSTAEDTIACEAE 220

230 -HISTIOPTERIS (AGARDH) J. SM.
4. SCHELPE & ANTHONY. 1986. FSA.
(Note author change for genus)

ADIANTACEAE 280

290 -ACTINIOPTERIS LINK
4. SCHELPE & ANTHONY. 1986. FSA.
200 A. RADIATA (KOENIG EX SWARTZ) LINK
(Note author change)

300 -ADIANTUM L.
4. SCHELPE & ANTHONY. 1986. FSA.
400 A. POIRETII WIKSTR.
500 A. poiretii Wikstr. var. sulphureum (Kaulf.) Tryon is only known in cultivation

330 -CERATOPTERIS BRONGN.
5. SCHELPE & ANTHONY. 1986. FSA.
C. cornuta sensu Jacobsen = C. THALICTROIDES
100 C. THALICTROIDES (L.) BRONGN.
(=C. cornuta sensu Jacobsen) 5

340 -CHEILANTHES SWARTZ
5. ANTHONY. 1984. CONTR. BOLUS HERB. 11.
1480 C. QUADRIPINNATA (FORSSK.) KUHN
(=Pellaea quadripinnata (Forssk.) Prantl) 5
1550 C. ROBUSTA (KUNZE) R. TRYON
(=Pellaea robusta (Kuntze) Hook.) 5

360 -PELLAEA LINK
P. quadripinnata (Forssk.) Prantl = CHEILANTHES QUADRIPINNATA
P. robusta (Kunze) Hook. = CHEILANTHES ROBUSTA

370 -PITYROGRAMMA LINK
4. SCHELPE & ANTHONY. 1986. FSA.
P. aurea (Willd.) C. Chr. Southern African specimens accommodated in P. ARGENTEA
P. calomelanos (L.) Link var. calomelanos does not occur in southern Africa

LINDSAEACEAE 390

390 -LINDSAEA DRYAND. APUD J.E. SM.
4. SCHELPE & ANTHONY. 1986. FSA.
(Note author change for genus)

GRAMMITIDACEAE 395

395 -GRAMMITIS SWARTZ
4. SCHELPE & ANTHONY. 1986. FSA.
100 G. POEPPIGANA (METT.) PICHI-SERM.
(Note author change)

POLYPODIACEAE 410

450 -PLEOPELTIS H.B.K. EX WILLD.
4. SCHELPE & ANTHONY. 1986. FSA.
(Note author change for genus)

470 -PYRROSIA MIRB.
4. SCHELPE & ANTHONY. 1986. FSA.
200 P. SCHIMPERIANA (METT. EX KUHN) ALSTON
(Note spelling correction)

DAVALLIACEAE 480

500 -NEPHROLEPIS SCHOTT
4. SCHELPE & ANTHONY. 1986. FSA.
N. undulata (Afzel. ex Swartz) J. Sm. does not occur in southern Africa.

510 -OLEANDRA CAV.
4. SCHELPE & ANTHONY. 1986. FSA.
(Note author correction for genus)

ASPLENIACEAE 520

520 -ASPLENIUM L.
4. SCHELPE & ANTHONY. 1986. FSA.
200 A. ADIANTUM-NIGRUM L. VAR. SOLIDUM (KUNZE) J.P. ROUX
2100 A. PREUSSII HIERON. EX BRAUSE

3100 A. THECIFERUM (H.B.K.) METT. VAR. CONCINNUM (SCHRAD.) SCHELPE
(Note author changes in these three species)

THELYPTERIDACEAE 532

531 -Amauropelta Kunze = THELYPTERIS
A. knysnaensis (N.C. Anthony & Schelpe) Parris = THELYPTERIS KNYSNAENSIS

532 -THELYPTERIS SCHMIDEL
6. PARRIS. 1986. KEW BULL. 41: 70.
650 T. KNYSNAENSIS N.C. ANTHONY & SCHELPE
(=Amauropelta knysnaensis (N.C. Anthony & Schelpe) Parris) 6 #

ASPIDIACEAE 590

650 -POLYSTICHUM ROTH
5. SCHELPE & ANTHONY. 1986. FSA.
P. lucidum sensu Schelpe, non (Burm. f.) Becherer = P. PUNGENS
300 P. MACLEAE (BAK.) DIELS
(Note correct spelling)
350 P. PUNGENS (KAULF.) PRESL
(=P. lucidum sensu Schelpe, non (Burm. f.) Becherer) 5

BLECHNACEAE 690

690 -BLECHNUM L.
4. SCHELPE & ANTHONY. 1986. FSA.
300 B. CAPENSE BURM. F.
(Note author change)

GYMNOSPERMAE Contributed by C. Reid

PODOCARPACEAE

0013000 -PODOCARPUS L'HERIT. EX PERS.
(Note author correction)

ANGIOSPERMAE

MONOCOTYLEDONAE Contributed by C. Reid

HYDROCHARITACEAE 85000

0087000 -EGERIA PLANCH.
2. COOK & URMI-KONIG. 1984. AQUATIC BOTANY 19: 73.

0095000 -OTTELIA PERS.
2. COOK, SYMOENS & URMI-KONIG. 1984. AQUATIC BOTANY 18: 263.

POACEAE Contributed by L. Smook 9900010

9900220 -HACKELOCHLOA KUNTZE
2. CLAYTON & RENVOIZE. 1982. FTEA.
3. VELDKAMP. 1986. BLUMEA 31: 281.
100 H. GRANULARIS (L.) KUNTZE 2

9900290 -COELORACHIS BRONGN.
1. CHIPPINDALL. 1955. GR. & PAST.
2. VELDKAMP. 1986. BLUMEA 31: 281.
100 C. CAPENSIS STAPF 1
(Note change in spelling of genus)

9900321 -Mnesithea Kunth
1. Veldkamp 1986. Blumea 31: 281.
Species could be transferred to this genus from HACKELOCHLOA and COELORACHIS

9900490 -VETIVERIA LEM.-LISANC.
(Note author change for genus)

9900730 -HYPARRHENIA FOURN.
2000 H. SCHIMPERI (A. RICH.) STAPF
(Note author change for both genus and species)

9900940 -ALLOTEROPSIS C.B. PRESL
(Note author correction for genus)

9901010 -PSEUDECHINOLAENA STAPF
100 P. POLYSTACHYA (KUNTH) STAPF
(Note author change)

9901020 -ERIOCHLOA KUNTH
75 E. MACCLOUNII STAPF
Tropical African species collected in Botswana. 1823 (Siambisso): Floodplain of Sibuyo (-BC), P.A. Smith 4299.

9901021 -ENTOLASIA STAPF
300 E. OLIVACEA STAPF
Tropical African species collected in Transvaal. 2329 (Pietersburg): Dap Naude Dam, Magoebaskloof area (-DB), Johannsmeier 372.

9901040 -BRACHIARIA (TRIN.) GRISEB.
(Note author change for genus)

9901870 -PERIBALLIA TRIN.
1. CHIPPINDALL. 1955. GR. & PAST.
2. TUTIN. 1980. FL. EUROP.
100 P. MINUTA (L.) ASCH. & GRAEBN. * 1
(Species treated in MOLINIERIELLA in Fl. Europ., without synonymy)

9901890 -DESCHAMPSIA BEAUV.
100 D. CESPITOSA (L.) BEAUV. *
(Note corrected spelling)

9901970 -HELICTOTRICHON SCHULT.
(Note author change for genus)

9902080 -PENTAMERIS BEAUV.
1. SCHWEICKERDT. 1938. FEDDES REPRIUM 42: 91.
400 P. OBTUSIFOLIA (HOCHST.) SCHWEICK.
(=P. squarrosa Stapf) 1
P. squarrosa Stapf = P. OBTUSIFOLIA

9902140 -PHRAGMITES ADANSON
(Note author correction for genus)

9902860 -ERAGROSTIS WOLF
(Note author correction for genus)

9902960 -CYNODON RICH.
(Note author change for genus)

9902970 -BRACHYACHNE STAPF
(Note author change for genus)

9903180 -TRIPOGON ROEM. & SCHULT.
(Note author change for genus)

9903310 -ELEUSINE GAERTN.
3. DE WET ET AL. 1984. AMER. J. BOT. 71: 550.
150 E. CORACANA (L.) GAERTN. SUBSP. AFRICANA (K.-O'BYRNE) HILU & DE WET
(=E. indica (L.) Gaertn. subsp. africana (K.-O'Byrne) S.M. Phillips) 3
E. indica (L.) Gaertn. subsp. africana (K.-O'Byrne) S.M. Phillips = E. CORACANA SUBSP. AFRICANA

9903311 -ACRACHNE CHIOV.
(Note author correction for genus)

9903360 -COELACHYRUM HOCHST. & NEES
(Note author correction for genus)

9903570 -ENNEAPOGON BEAUV.
(Note author change for genus)

9903730 -CYNOSURUS L. Revision: H.P. Linder (BOL).
2. LINDER. 1986. BOTHALIA 16: 61.
50 C. COLORATUS LEHM. EX NEES *

9903980 -DACTYLIS L. Revision: H.P. Linder (BOL).
(Note correction for genus number)

9904040 -BRIZA L. Revision: H.P. Linder (BOL).
B. triloba Nees * = CHASCOLYTRUM SUBARISTATUM

9904041 -CHASCOLYTRUM DESV.
1. MATTHEI. 1975. WILLDENOWIA, BEIHEFT 8: 79.
100. C. SUBARISTATUM (LAM.) DESV. *
(=Briza triloba Nees) 1

9904070 -POA L. Revision: H.P. Linder (BOL).
#. PRE HERBARIUM PRACTICE, FOLLOWING LINDER.
P. atherstonei Stapf = P. BINATA
P. bidentata Stapf = P. PRATENSIS
400 P. BINATA NEES
(=P. atherstonei Stapf) #
450 P. BULBOSA L.
(=P. vivipara (L.) Willd.) #
550 P. LEPTOCLADUS A. RICH
600 P. PRATENSIS L. *
(=P. bidentata Stapf) #
650 P. TRIVIALIS L. *
P. vivipara (L.) Willd. = P. BULBOSA

9904150 -PUCCINELLIA PARL. Revision: H.P. Linder (BOL).

#. PRE HERBARIUM PRACTICE, FOLLOWING LINDER.
250 P. DISTANS (L.) PARL. *

9904170 -FESTUCA L. Revision: H.P. Linder (BOL).
2. CLAYTON. 1985. KEW BULL. 40: 727.
3. LINDER. 1986. BOTHALIA 16: 61.
75 F. AFRICANA (HACK.) CLAYTON
(=Pseudobromus africanus (Hack.) Stapf) 2
(=Pseudobromus silvaticus K. Schum.) 2
F. arundinacea Schreb. = F. ELATIOR
725 F. DRACOMONTANA LINDER
750 F. ELATIOR L. *
(=F. arundinacea Schreb.) 3
1100 F. VULPIOIDES STEUD.

9904250 -Pseudobromus = FESTUCA
P. africanus (Hack.) Stapf = F. AFRICANA
P. silvaticus K. Schum. = F. AFRICANA

9904280 -BROMUS L. Revision: H.P. Linder (BOL).
3. PINTO-ESCOBAR. 1976. CALDASIA 11: 9-16.
4. LINDER. 1986. BOTHALIA 16: 61.
#. PRE HERBARIUM PRACTICE, FOLLOWING LINDER
25 B. ALOPECURUS POIR. *
50 B. CATHARTICUS VAHL *
(=B. unioloides H.B.K.) 3
(=B. willdenowii Kunth) 3
350 B. FIRMIOR (NEES) STAPF
(=B. firmior (Nees) Stapf var. firmior) #
(=B. firmior (Nees) Stapf var. leiorhachis Stapf) #
B. firmior (Nees) Stapf var. firmior = B. FIRMIOR
B. firmior (Nees) Stapf var. leiorhachis Stapf = B. FIRMIOR
420 B. HORDEACEUS L. SUBSP. FERRONII (MABILLE) P.M. SM.
430 B. HORDEACEUS L. SUBSP. MOLLIFORMIS (J. LLOYD) MAIRE & WEILLER
(=B. molliformis Lloyd) #
B. japonicus sensu Chippind., non Thunb. var. japonicus = B. PECTINATUS
B. japonicus sensu Chippind., non Thunb. var. velutinus (Nocc.) Aschers & Graebn. = B. PECTINATUS
B. molliformis Lloyd = B. HORDEACEUS SUBSP. MOLLIFORMIS
1000 B. NATALENSIS STAPF
(=B. natalensis Stapf var. lasiophilus Stapf) #
(=B. speciosus sensu Compton, non Nees) #
B. natalensis Stapf var. lasiophilus Stapf = B. NATALENSIS
1115 B. PECTINATUS THUNB.
(=B. japonicus sensu Chippind., non Thunb. var. japonicus) #
(=B. japonicus sensu Chippind., non Thunb. var. velutinus (Nocc.) Aschers. & Graebn.) #
1125 B. RIGIDUS ROTH *
B. speciosus sensu Compton, non Nees = B. NATALENSIS
1300 B. TECTORUM L. *
B. unioloides H.B.K. = B. CATHARTICUS
B. willdenowii Kunth = B. CATHARTICUS

9904330 -LOLIUM L. Revision: H.P. Linder (BOL).
#. PRE HERBARIUM PRACTICE, FOLLOWING LINDER.
L. loliaceum (Bory & Chaup.) Hand.-Mazz = L. RIGIDUM
325 L. MULTIFLORUM X PERENNE
350 L. RIGIDUM GAUDIN *
(=L. loliaceum (Bory & Chaup.) Hand.-Mazz) #

9904340 -AGROPYRON GAERTN.
1. CHIPPINDALL. 1955. GR. & PAST.
2. DEWEY. 1984. GENOMIC CLASSIFICATION IN GUSTAFSON, GENE MANIPULATION.: 209.
100 A. DISTICHUM (THUNB.) BEAUV. 1
= THINOPYRUM DISTICHUM (THUNB.) LOEVE 2
200 A. REPENS (L.) BEAUV. * 1
= ELYTRIGIA REPENS (L.) NEVSKI 2

Morphological generic concepts (1) and cytogenetic generic concepts (2) do not coincide in the tribe Triticeae. Alternative names are therefore presented without implying synonymy.

-ELYTRIGIA DESV. = AGROPYRON P.P.
1. CHIPPINDALL. 1955. GR. & PAST.
2. DEWEY. 1984. GENOMIC CLASSIFICATION IN GUSTAFSON, GENE MANIPULATION.: 209.
E. REPENS (L.) NEVSKI * 2
= AGROPYRON REPENS (L.) BEAUV. * 1

-THINOPYRUM LOEVE = AGROPYRON P.P.
1. CHIPPINDALL. 1955. GR. & PAST.
2. DEWEY. 1984. GENOMIC CLASSIFICATION IN GUSTAFSON, GENE MANIPULATION.: 209.
T. DISTICHUM (THUNB.) LOEVE * 2
= AGROPYRON DISTICHUM (THUNB.) BEAUV. * 1

9904510 -HORDEUM L.
3. HUMPHRIES. 1980. FL. EUROP.
4. DEWEY. 1984. GENOMIC CLASSIFICATION IN GUSTAFSON, GENE MANIPULATION.: 209.
250 H. MARINUM HUDS. SUBSP. GUSSONEANUM (PARL.) THELL. * 3 = CRITESION MARINUM (HUDS.) LOEVE * 4
320 H. MURINUM L. SUBSP. MURINUM * 3
= CRITESION MURINUM (L.) LOEVE * 4
385 H. STENOSTACHYS GODR. * 3
= CRITESION STENOSTACHYS (GODR.) LOEVE * 4

Morphological generic concepts (3) and cytogenetic generic concepts (4) do not coincide in the tribe Triticeae. Alternative names are therefore presented without implying synonymy.

-CRITESION RAF. = HORDEUM P.P.
1. HUMPHRIES. 1980. FL. EUROP.
2. DEWEY. 1984. GENOMIC CLASSIFICATION IN GUSTAFSON, GENE MANIPULATION.: 209.
C. MARINUM (HUDS.) LOEVE * 2
= HORDEUM MARINUM HUDS. * 1
C. MURINUM (L.) LOEVE * 2
= HORDEUM MURINUM L. * 1
C. STENOSTACHYS (GODR.) LOEVE * 2
= HORDEUM STENOSTACHYS GODR. * 1

CYPERACEAE 452000

0459000 -CYPERUS L.
10. FOSBERG. 1976. KEW BULL. 31: 835.
11. BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 356.
###. PRE HERBARIUM PRACTICE, FOLLOWING REID.
C. alopecuroides sensu Thunb., non Rottb. = MARISCUS THUNBERGII
C. niveus Retz. var. flavissimus (Schrad.) Lye = C. OBTUSIFLORUS VAR. SPHAEROCEPHALUS
C. niveus Retz. var. leucocephalus (Kunth) Fosberg = C. OBTUSIFLORUS VAR. OBTUSIFLORUS
C. obtusiflorus Vahl var. flavissimus Boeck. = C. OBTUSIFLORUS VAR. SPHAEROCEPHALUS
4750 C. OBTUSIFLORUS VAHL VAR. SPHAEROCEPHALUS (VAHL) KUEKENTH.
(=C. niveus Retz. var. flavissimus (Schrad.) Lye) 11, ###
(=C. niveus Retz. var. leucocephalus (Kunth) Fosberg) 11, ###
(=C. obtusiflorus Vahl var. flavissimus Boeck.) 11, ###
(=C. sphaerocephalus Vahl) 11, ###
C. sphaerocephalus Vahl = C. OBTUSIFLORUS VAR. SPHAEROCEPHALUS

0459030 -MARISCUS GAERTN. Revision: P.J. Vorster (STE-U).
6. VORSTER. 1986. S. AFR. J. BOT. 52: 181.
7. VORSTER. 1986. S. AFR. J. BOT. 52: 265.
850 M. DRAKENSBERGENSIS P.J. VORSTER 6
2860 M. SOLIDUS (KUNTH) P.J. VORSTER
2950 M. THUNBERGII (VAHL) SCHRAD.
(=Cyperus alopecuroides sensu Thunb., non Rottb.) 7
(=M. riparius Schrad. var. robustior C.B. Cl.) 6

0465000 -FICINIA SCHRAD. Revision: T.H. Arnold & C. Reid (PRE).
6. BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 357.
200 F. ACUMINATA (NEES) NEES
(Note author change)
1750 F. CRINITA (POIR.) B.L. BURTT
(=F. oligantha (Steud.) J. Raynal var. crinita (Poir.) J. Raynal) 6
2650 F. FILICULMEA B.L. BURTT
3920 F. NANA B.L. BURTT

F. oligantha (Steud.) J. Raynal var. crinita (Poir.) J. Raynal = F. CRINITA
5950 F. UNDOSA B.L. BURTT

0467000 -FUIRENA ROTTB.
4. FORBES. 1986. S. AFR. J. BOT. 52: 237.
F. microlepis sensu C.B. Cl., non Kunth = F. OBCORDATA
950 F. OBCORDATA P.L. FORBES
(=F. microlepis sensu C.B. Cl., non Kunth) 4

0468000 -SCIRPUS L.
S. macer Boeck. = ISOLEPIS COSTATA VAR. MACRA

0468020 -ISOLEPIS R. BR.
6. BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 362.
20 I. ANGELICA B.L. BURTT
220 I. COSTATA (BOECK.) A. RICH. VAR. COSTATA
230 I. COSTATA (BOECK.) A. RICH. VAR. MACRA (BOECK.) B.L. BURTT
(=Scirpus macer Boeck.) 6
730 I. PELLOCOLEA B.L. BURTT

0471010 -BULBOSTYLIS KUNTH
5. BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 353.
990 B. ORITREPHES (REDLEY) C.B. CL. SUBSP. AUSTRALIS B.L. BURTT
1000 B. ORITREPHES (RIDLEY) C.B. CL. SUBSP. ORITREPHES

0515000 -SCLERIA BERG. Revision: E.F. Hennessy (Durban-Westville).
2800 S. POIFORMIS RETZ.
(Note spelling correction)

0521000 -SCHOENOXIPHIUM NEES
2. BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 364.
50 S. ALTUM KUKKONEN
123 S. BRACTEOSUM KUKKONEN
126 S. BURTTII KUKKONEN
254 S. MOLLE KUKKONEN
580 S. STRICTUM KUKKONEN

0525000 -CAREX L. Revision: C. Reid (PRE).
3. KUEKENTHAL. 1909. PFLANZENR. 38 (IV,20).
4. NELMES. 1940. KEW BULL. 1940: 136.
7. RAYMOND. 1964. NATUR. CANADA 91: 126.
8. GORDON-GRAY IN ROSS. 1972. FL. NATAL.
320 C. AUSTRO-AFRICANA (KUEKENTH.) RAYMOND
(=C. cernua Boott. var. austro-africana Kuekenth.) 7
C. cernua Boott. var. austro-africana Kuekenth. = C. AUSTRO-AFRICANA
600 C. COGNATA KUNTH VAR. COGNATA
600 C. COGNATA KUNTH VAR. DRAKENSBERGENSIS (C.B. CL.) KUEKENTH.
(=C. drakensbergensis C.B. Cl.) 3
C. drakensbergensis C.B. Cl. = C. COGNATA VAR. DRAKENSBERGENSIS
C. huttoniana Kuekenth. = C. ZULUENSIS
1500 C. MOSSII NELMES
(=C. petitiana sensu Kuekenth., non A. Rich.) 4
C. petitiana sensu Kuekenth., non A. Rich. = C. MOSSII
2300 C. ZULUENSIS C.B. CL.
(=C. huttoniana Kuekenth.) 3,8

JUNCACEAE 930000

0936000 -JUNCUS L.
4. HILLIARD & BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 367.
2050 J. MOLLIFOLIUS HILLIARD & BUPTT

LILIACEAE 942000

0972000 -WURMBEA THUNB. Revision: B. Nordenstam (S).
4. NORDENSTAM. 1986. OPERA BOT. 87: 1.
W. conferta N.E. Br. = W. SPICATA VAR. USTULATA
350 W. DOLICHANTHA B. NORD.
550 W. HIEMALIS B. NORD.
600 W. INUSTA (KUNTH) B. NORD.
W. longiflora Willd. = W. MONOPETALA
1000 W. MARGINATA (DESR. IN LAM.) B. NORD.
(=W. purpurea Dryand.) 4
1150 W. MONOPETALA (L. F.) B. NORD.
(=W. longiflora Willd.) 4
W. purpurea Dryand. = W. MARGINATA
1270 W. RECURVA B. NORD.
1400 W. ROBUSTA B. NORD.
1450 W. SPICATA (BURM. F.) DUR. & SCHINZ VAR. SPICATA
1460 W. SPICATA (BURM. F.) DUR. & SCHINZ VAR. USTULATA (B. NORD.) B. NORD.
(=W. conferta N.E. Br.) 4
(=W. ustulata B. Nord.) 4
W. ustulata B. Nord. = W. SPICATA VAR. USTULATA
1700 W. VARIABILIS B. NORD.
88888 W. HYBRID

0984000 -BULBINELLA KUNTH
##. PRE HERBARIUM PRACTICE, FOLLOWING P.L. PERRY.
140 B. CILIOLATA KUNTH
330 B. LATIFOLIA KUNTH
340 B. NUTANS (THUNB.) DUR. & SCHINZ

1024000 -KNIPHOFIA MOENCH
3. CODD. 1986. BOTHALIA 16: 231.
250 K. ANGUSTIFOLIA (BAK.) CODD
(=K. rufa sensu Codd, non Bak.) 3
2150 K. ICHOPENSIS BAK. EX SCHINZ VAR. ACIFORMIS CODD
2200 K. ICHOPENSIS BAK. EX SCHINZ VAR. ICHOPENSIS
K. rufa sensu Codd, non Bak. = K. ANGUSTIFOLIA

1026000 -ALOE L. Revision: H.F. Glen & D.S. Hardy (PRE).
5. PLOWES. 1986. ALOE 23: 32.
#. PRE HERBARIUM PRACTICE, FOLLOWING GLEN & HARDY.
750 A. ANGOLENSIS BAK. #
1250 A. BARBERIAE T.-DYER #
7750 A. INCONSPICUA PLOWES 5

1050000 -NOTHOSCORDUM KUNTH
3. STEARN. 1986. TAXON 35: 335.
N. fragrans (Vent.) Kunth = N. GRACILE
50 N. GRACILE (AIT.) STEARN *
(=N. fragrans (Vent.) Kunth) 1
(=N. inodorum (Ait.) Nicholson) 2
N. inodorum (Ait.) Nicholson = N. GRACILE

1080000 -URGINEA STEINH.
U. forsteri Bak. = DRIMIA CAPENSIS

1081000 -GALTONIA DECNE.
2. HILLIARD & BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 369.
250 G. REGALIS HILLIARD & BURTT

1082000 -DRIMIA JACQ. EX WILLD.
4. WIJNANDS. 1983. BOTANY OF COMMELINS: 130.
450 D. CAPENSIS (BURM. F.) WIJNANDS
(=D. forsteri (Bak.) Oberm.) 4
(=Urginea forsteri Bak.) 4

1098000 -LACHENALIA JACQ. F. EX MURRAY
8. BARKER. 1984. JL S. AFR. BOT. 50: 535.
350 L. ARBUTHNOTIAE W.F. BARKER

1110000 -SANSEVIERIA THUNB.
#. PRE HERBARIUM PRACTICE, FOLLOWING OBERMEYER.
S. angustiflora Lindb. = S. HYACINTHOIDES
200 S. HYACINTHOIDES (L.) DRUCE
(=S. angustiflora Lindb.) #

AMARYLLIDACEAE 1166000

1175000 -NERINE HERB.
4. DOUGLAS. 1985. BOTHALIA 15: 545.
N. breachiae W.F. Barker = N. HUMILIS
N. flexuosa (Jacq.) Herb., p.p. = N. HUMILIS
950 N. HUMILIS (JACQ.) HERB.
(=N. breachiae W.F. Barker) #
(=N. flexuosa (Jacq.) Herb., p.p.) 4
(=N. peersii W.F. Barker) #
(=N. pulchella Herb.) 4
(=N. tulbaghensis W.F. Barker) 4
N. peersii W.F. Barker = N. HUMILIS
N. pulchella Herb. = N. HUMILIS
N. tulbaghensis W.F. Barker = N. HUMILIS

1176000 -AMARYLLIS L.
2. GOLDBLATT. 1984. TAXON 33: 511.

1186000 -GETHYLLIS L. Revision: D. Muller-Doblies (Herb. M-D).
3. MULLER-DOBLIES. 1986. ENUMERATION. WILLDENOWIA 15: 465.
220 G. BARKERAE D. MULLER-DOBLIES SUBSP. BARKERAE
240 G. BARKERAE D. MULLER-DOBLIES SUBSP. PAUCIFOLIA D. MULLER-DOBLIES
300 G. BRITTENIANA BAK. SUBSP. BRITTENIANA
320 G. BRITTENIANA BAK. SUBSP. BRUYNSII D. MULLER-DOBLIES
340 G. BRITTENIANA BAK. SUBSP. HERREI (L. BOL.) D. MULLER-DOBLIES
(=G. herrei L. Bol.) 3
450 G. CAVIDENS D. MULLER-DOBLIES
500 G. CILIARIS (THUNB.) THUNB. SUBSP. CILIARIS

510 G. CILIARIS (THUNB.) THUNB. SUBSP. LONGITUBA (L. BOL.) D. MULLER-DOBLIES
530 G. FIMBRIATULA D. MULLER-DOBLIES
(=G. longituba L. Bol.) 3
550 G. GRANDIFLORA D. MULLER-DOBLIES
560 G. GREGORIANA D. MULLER-DOBLIES
580 G. HALLII D. MULLER-DOBLIES
590 G. HEINZEANA D. MULLER-DOBLIES
G. herrei L. Bol. = G. BRITTENIANA SUBSP. HERREI
650 G. KAAPENSIS D. MULLER-DOBLIES
750 G. LATA L. BOL. SUBSP. LATA
770 G. LATA L. BOL. SUBSP. ORBICULARIS D. MULLER-DOBLIES
G. longituba L. Bol. = G. CILIARIS SUBSP. LONGITUBA
1260 G. OLIGOPHYLLA D. MULLER-DOBLIES
1270 G. OLIVERORUM D. MULLER-DOBLIES
1280 G. PECTINATA D. MULLER-DOBLIES
1450 G. ROGGEVELDENSIS D. MULLER-DOBLIES
1600 G. SPIRALIS (THUNB.) THUNB.
(=G. unilateralis L. Bol.) 3
1650 G. TRANSKAROOICA D. MULLER-DOBLIES
G. unilateralis L. Bol. = G. SPIRALIS
1850 G. UTEANA D. MULLER-DOBLIES

1187000 -APODOLIRION BAK. Revision: D. Muller-Doblies (Herb. M-D).
2. D. MULLER-DOBLIES. 1986. ENUMERATION. WILLDENOWIA 15: 465.
50 A. AMYANUM D. MULLER-DOBLIES
200 A. BUCHANANII BAK.
(=A. ettae Bak.) 2
(=A. mackenii Bak.) 2
250 A. CEDARBERGENSE D. MULLER-DOBLIES

1191000 -CYRTANTHUS L. F.
7. HILLIARD & BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 189.
550 C. BRACHYSIPHON HILLIARD & BURTT
1050 C. ELATUS (JACQ.) TRAUB
(=C. purpureus (Ait.) Traub) 7
(=Vallota purpurea (Ait.) Herb.) 3, 7
(=Vallota speciosa (L. f.) Dur. & Schinz) 3, 7

HYPOXIDACEAE 1229010

1230000 -HYPOXIS L.
3. HILLIARD & BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 201.
550 C. COLCHICIFOLIA BAK.
(=E. latifolia Hook.) 3
(=E. oligotricha Bak.) 3
2100 H. HEMEROCALLIDEA FISCH. & MEY.
(=H. rooperi S. Moore) 3
2250 H. IRIDIFOLIA BAK.
(=H. nitida Verdoorn) 3
(=H. obtusa Burch. ex Edwards) 3
H. latifolia Hook. = H. COLCHICIFOLIA
H. nitida Verdoorn = H. IRIDIFOLIA
3720 H. OBTUSA KER-GAWL.
H. obtusa Burch. ex Edwards = H. IRIDIFOLIA
H. oligotricha Bak. = H. COLCHICIFOLIA
H. rooperi S. Moore = S. HEMEROCALLIDEA

VELLOZIACEAE 1246000

1247010 -XEROPHYTA JUSS.
3. HILLIARD. 1986. NOTES R. BOT. GDN EDINB. 43: 405.
250 X. LONGICAULIS HILLIARD

IRIDACEAE 1259000

1265000 -MORAEA MILL.
7. GOLDBLATT. 1982. ANN. MISSOURI BOT. GDN 73: 102.
8. GOLDBLATT. 1982. ANN. MISSOURI BOT. GDN 73: 140.
#. PRE HERBARIUM PRACTICE, FOLLOWING GOLDBLATT.
2070 M. DESERTICOLA GOLDBL.
2370 M. EXILIFLORA GOLDBL.
2870 M. FUGAX (DELAROCHE) JACQ. SUBSP. FILICAULIS (BAK.) GOLDBL.
3000 M. FUGAX (DELAROCHE) JACQ. SUBSP. FUGAX
3850 M. GRANITICOLA GOLDBL.
3870 M. HEXAGLOTTIS GOLDBL.
4470 M. MACROCARPA GOLDBL.
6250 M. PSEUDOSPICATA GOLDBL.
6710 M. RIGIDIFOLIA GOLDBL.
8220 M. VENENATA DINTER
8500 M. WORCESTERENSIS GOLDBL.

1295000 -ARISTEA AIT.
4. VINCENT. 1985. J. AFR. J. BOT. 51: 209.

1301000 -HESPERANTHA KER-GAWL. Revision: O.M. Hilliard & B.L. Burtt (E).
3. HILLIARD & BURTT. 1979. NOTES R. BOT. GDN EDINB. 37: 302.
5. HILLIARD & BURTT. 1982. NOTES R. BOT. GDN EDINB. 40: 278.
7. HILLIARD & BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 407.
150 H. ALBOROSEA HILLIARD & BURTT
300 H. BAURII BAK. SUBSP. BAURII
350 H. BAURII BAK. SUBSP. FORMOSA HILLIARD & BURTT
600 H. CANDIDA BAK.
720 H. CURVULA HILLIARD & BURTT
1150 H. GLAREOSA HILLIARD & BURTT
1170 H. GRACILIS BAK.
1510 H. HUTCHINGSIAE HILLIARD & BURTT
1555 H. INGELIENSIS HILLIARD & BURTT
1575 H. LACTEA BAK.
2650 H. PUBERINERVIA HILLIARD & BURTT
2720 H. PULCHRA BAK.
2864 H. SCOPULOSA HILLIARD & BURTT
3150 H. TYSONII BAK.

1306010 -CROCOSMIA PLANCH. Revision: M.P. de Vos (STEU).
4. WIJNANDS. 1986. BOTHALIA 16: 51.
100 C. AUREA (PAPPE EX HOOK.) PLANCH. VAR. AUREA
150 C. AUREA (PAPPE EX HOOK.) PLANCH. VAR. MACULATA BAK.
800 C. X CROCOSMIIFLORA (LEMOINE EX BURBIDGE & DEAN) N.E. BR.

1311000 -GLADIOLUS L.
6. HILLIARD & BURTT. 1986. NOTES. R. BOT. GDN EDINB. 43: 206.
7250 G. LOTENIENSIS HILLIARD & BURTT

1315000 -WATSONIA MILL. Revision: P. Goldblatt (MO).
#. PRE HERBARIUM PRACTICE, FOLLOWING GOLDBLATT.
200 W. ANGUSTA (JACQ.) KER-GAWL.
800 W. COCCINEA HERB.
1500 W. FULGENS (ANDR.) KER-GAWL.
1900 W. HUMILIS MILL.
2150 W. LACCATA (JACQ.) KER-GAWL.
4000 W. VANDERSPUYIAE L. BOL.

ORCHIDACEAE 1389000

1434000 -DISA BERG.
7. ANDERSON & V.D. MERWE. 1986. VELD & FLORA 72: 11.
8. LINDER. 1986. BOTHALIA 16: 56.
1750 D. FILICORNIS (L. F.) THUNB.
(=D. patens Swartz) 8
D. lutea Linder = O. TENUIFOLIA
D. patens sensu (L. f.) Thunb., non Swartz = D. TENUIFOLIA
D. patens Swartz = D. FILICORNIS
6240 D. TENUIFOLIA SWARTZ
(=D. patens sensu (L. f.) Thunb., non Swartz) 8
(=D. lutea Linder) 8
6850 D. UNIFLORA X CAULESCENS

1440000 -CORYCIUM SWARTZ
2. OLIVER. 1985. S. AFR. J. BOT. 52: 256.
650 C. INGEANUM E.G.H. OLIVER

1830030 -YPSILOPUS SUMMERH.
2. CRIBB & STEWART. 1985. KEW BULL 40: 417.
50 Y. ERECTUS (CRIBB) CRIBB & STEWART
(=Y. longifolius (Kraenzl.) Summerh. subsp. erectus Cribb) 2
Y. longifolius (Kraenzl.) Summerh. subsp. erectus Cribb = Y. ERECTUS

1837000 -MYSTACIDIUM LINDL.
M. caffrum (H. Bol.) H. Bol. = MARGELLIANTHA CAFFRA

1837010 -MARGELLIANTHA CRIBB
1. CRIBB. 1979. KEW BULL. 34: 329.
2. CRIBB & STEWART. 1985. KEW BULL. 40: 413.
100 M. CAFFRA (H. BOL.) CRIBB & STEWART
(=Mystacidium caffrum (H. Bol.) 2

DICOTYLEDONAE

SANTALACEAE Contributed by G. Germishuizen 2096000

2118000 -THESIUM L. Revision: O.M. Hilliard (E).
5. BRENAN. 1985. KEW BULL. 40: 82.
3450 T. DAVIDSONAE BRENAN

ROSACEAE Contributed by G. Germishuizen 3316000

3375000 -ALCHEMILLA L.
3. HILLIARD & BURTT. 1986. NOTES. R. BOT GDN EDINB. 43: 370.
250 A. COLURA HILLIARD

FABACEAE Contributed by G. Germishuizen 3436000

3468000 -ENTADA ADANS.
E. spicata (E. Mey.) Druce = ADENOPODIA SPICATA

3468020 -ADENOPODIA PRESL
1. BRENAN. 1986. KEW BULL. 41: 77.
100 A. SPICATA (E. MEY.) PRESL
(=Entada natalensis Benth. var. aculeata Harv.) 1
(=Entada spicata (E. Mey.) Druce) 1
(=Mimosa spicata E. Mey.) 1

3602000 -SOPHORA L. Revision: C.H. Stirton (K).
S. capensis L. = VIRGILIA OROBOIDES SUBSP. OROBOIDES
S. oroboides Berg. = VIRGILIA OROBOIDES SUBSP. OROBOIDES

3608000 -VIRGILIA POIRET Revision: B-E. van Wyk (Rand AU).
2. VAN WYK. 1986. S. AFR. J. BOT. 52: 347-353.
V. capensis (L.) Lam. = V. OROBOIDES SUBSP. OROBOIDES
V. capensis (L.) Poir. subsp. capensis = V. OROBOIDES SUBSP. FERRUGINEA
V. capensis Lam. sensu Pole Evans = V. DIVARICATA
100 V. DIVARICATA ADAMSON
(=V. capensis sensu Pole Evans, non Lam.) 2
150 V. OROBOIDES (BERG.) SALTER SUBSP. FERRUGINEA B.-E. VAN WYK
(=V. capensis (L.) Poir. subsp. capensis) 2
200 V. OROBOIDES (BERG.) SALTER SUBSP. OROBOIDES
(=Hypocalyptus capensis (L.) Thunb.) 2
(=Podalyria capensis (L.) Willd.) 2
(=Sophora capensis L.) 2
(=Sophora oroboides Berg.) 2
(=V. capensis (L.) Lam.) 2
(=V. oroboides (Berg.) Salter) 2

3621000 -PODALYRIA WILLD. Revision: S. Schelpe (BOL).
P. capensis (L.) Willd = VIRGILIA OROBOIDES SUBSP. OROBOIDES

3657000 -LOTONONIS (DC.) ECKL. & ZEYH. Revision: B-E. van Wyk (Rand AU).
5. HILLIARD & BURTT. 1986. NOTES. R. BOT. GDN EDINB. 43: 210.
1100 L. BIFLORA (H. BOL.) DUEMMER
(=L. wylei J.M. Wood) 5
L. wyliei J.M. Wood = L. BIFLORA

3657040 -Genista L. Southern African species moved to CYCLOPIA, POLHILLIA, MELOLOBIUM
G. involucrata Thunb. = MELOLOBIUM INVOLUCRATUM

3665000 -MELOLOBIUM ECKL. & ZEYH.
2. STIRTON. 1986. S. AFR. J. BOT. 52: 354-356.
970 M. INVOLUCRATUM (HARV.) C.H. STIRTON
(=Argyrolobium involucratum (Thunb.) Harv.) 2
(=Genista involucrata (Thunb.) Briq.) 2
(=Psoralea involucrata Thunb.) 2

3673000 -ARGYROLOBIUM ECKL. & ZEYH.
A. involucratum (Thunb.) Harv. = MELOLOBIUM INVOLUCRATUM

3683000 -HYPOCALYPTUS THUNB.
H. capensis (L.) Thunb. = VIRGILIA OROBOIDES SUBSP. OROBOIDES

3702000 -INDIGOFERA L. Revision: B. Schrire & G. Germishuizen (PRE).
6. HILLIARD & BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 207-210.
17630 I. PSEUDOEVANSII HILLIARD & BURTT

3703000 -PSORALEA L. Revision: C.H. Stirton (K).
P. involucrata Thunb. = MELOLOBIUM INVOLUCRATUM

GERANIACEAE Contributed by M. van Wyk and G. Germishuizen 3924000

3928000 -PELARGONIUM L'HERIT. Revision: J.J.A. van der Walt & P. Vorster (STE-U).
13. VAN DER WALT & BOUCHER. 1986. S. AFR. J. BOT. 52: 438-462.
14. VORSTER. 1986. S. AFR. J. BOT. 52: 481-484.
P. caucalifolium Jacq. = P. CAUCALIFOLIUM SUBSP. CAUCALIFOLIUM
3450 P. CAUCALIFOLIUM JACQ. SUBSP. CAUCALIFOLIUM
(=P. caucalfolium Jacq.) 13
3455 P. CAUCALIFOLIUM JACQ. SUBSP. CONVOLVULIFOLIUM (SCHLTR. EX KNUTH) J.J.A. VAN DER WALT
(=P. convolvulifolium Schltr. ex Knuth) 13
P. convolvulifolium Schltr. ex Knuth = P. CAUCALIFOLIUM SUBSP. CONVOLVULIFOLIUM
5775 P. EXHIBENS VORSTER
P. longicaule Jacq. = P. LONGICAULE VAR. LONGICAULE
9525 P. LONGICAULE JACQ. VAR. ANGUSTIPETALUM BOUCHER
9530 P. LONGICAULE JACQ. VAR. LONGICAULE
(=P. longicaule Jacq.) 13
10400 P. MULTICAULE JACQ. SUBSP. MULTICAULE
10450 P. MULTICAULE JACQ. SUBSP. SUBHERBACEUM (KNUTH) J.J.A. VAN DER WALT
(=P. subherbaceum Knuth) 13
P. subherbaceum Knuth = P. MULTICAULE SUBSP. SUBHERBACEUM
16420 P. SUBURBANUM CLIFFORD EX BOUCHER SUBSP. BIPINNATIFIDUM (HARV.) BOUCHER
(=P. urbanum (Eckl. & Zeyh.) Steud. var. bipinnatifidum Harv.) 13
16425 P. SUBURBANUM CLIFFORD EX BOUCHER SUBSP. SUBURBANUM
(=P. urbanum (Eckl. & Zeyh.) Steud. var. pinnatifidum Harv.) 13
P. urbanum (Eckl. & Zeyh.) Harv. var. pinnatifidum Harv. = P. SUBURBANUM SUBSP. SUBURBANUM
P. urbanum (Eckl. & Zeyh.) Harv. var. bipinnatifidum Harv. = P. SUBURBANUM SUBSP. BIPINNATIFIDUM

THYMELAEACEAE Contributed by E. Retief 5429000

5435000 -GNIDIA L.
19. HILLIARD & BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 218.
5320 G. RENNIANA HILLIARD & BURTT

5436000 -STRUTHIOLA L.
4. PETERSON & HILLIARD. 1986. NOTES R. BOT. GDN EDINB. 43: 219.
125 S. ANGUSTILOBA PETERSON & HILLIARD

APIACEAE 5893000

6016010 -DRACOSCIADIUM HILLIARD & BURTT
1. HILLIARD & BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 220.
100 D. ITALAE HILLIARD & BURTT
200 D. SANICULIFOLIUM HILLIARD & BURTT

6045000 -POLEMANNIA ECKL. & ZEYH.
4. HILLIARD & BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 225.
350 P. SIMPLICIOR HILLIARD & BURTT

EBENACEAE Contributed by E. Retief 6403000

6403000 -Royena L.
R. parviflora Hiern = DIOSPYROS SIMII

6404000 -EUCLEA MURRAY
3. RETIEF. 1986. BOTHALIA 16: 228.
550 E. DEWINTERI RETIEF

6406000 -DIOSPYROS L.
1. DE WINTER. 1963. FSA 26: 54.
2500 D. SIMII (KUNTZE) DE WINTER
(=Royena parviflora Hiern)

PERIPLOCACEAE Contributed by E. Retief 6729000

6747000 -RAPHIONACME HARV. Revision: H.J.T. Venter (BLFU).
6. VENTER & VERHOEFEN. 1986. S. AFR. J. BOT. 52: 332.
925 R. NAMIBIANA VENTER & VERHOEFEN

ASCLEPIADACEAE Contributed by E. Retief 6752000

6791000 -ASCLEPIAS L. Revision: A. Nicholas (PRE).
5. NICHOLAS. 1986. NOTES R. BOT. GDN EDINB. 43: 192.
6. HILLIARD & BURTT. 1986. NOTES R. BOT. GDN EDINB. 43: 193.
4450 A. OREOPHILA A. NICHOLAS
6250 A. XYSMALOBIOIDES HILLIARD & BURTT

Bothalia 17,2: 277–296 (1987)

REVIEW OF THE WORK OF THE BOTANICAL RESEARCH INSTITUTE 1986/1987

1st April 1986 – 31st March 1987

CONTENTS

INTRODUCTION

During the year under review a departmental committee was appointed to look into the state of botany in the Department of Agriculture and Water Supply. This action is to be welcomed because it implies that a close look will be taken at the mandate, performance and productivity of the Botanical Research Institute, an organization which supplies national research and other services in spite of being accommodated in an 'own affairs' Department. Botany, as practised by different state departments, is highly fragmented and it is to be hoped that an investigation of this pressing issue will be undertaken in the near future.

It cannot be doubted that the numerous adjustments made in recent years within our Department as well as the appointment of the abovementioned committee has engendered uncertainties which have been extremely unsettling to our staff. It is with satisfaction, therefore, that we can report that the scientific productivity of the Institute has, nevertheless, remained on par. Ninety publications varying from very short to long, from high level scientific contributions to extensive general purpose reference works appeared during the year. The definitive publication on the South African biomes will remain a standard work on the subject for some time to come and the ecological bibliography, as well as the problem plant catalogue, are examples of valuable general reference works.

Special attention is being devoted to the highly important grass family in order to support the developing Pasture Research Centre in its activities. Grasses are now being studied in depth from the anatomical and cytogenetic points of view and a start has been made with the taxonomic aspects.

At the same time the BRI has consolidated its position as a botanical institute in the forefront of computer applications. Two of our staff participate in international databank operations and we have acquired the DELTA databank system (Descriptive Language for Taxonomy) as a co-operating institute. In addition, the herbarium computerized management system is in partial operation and will, when complete, be one of the most advanced of its kind in the world.

Exploration of our flora is continuing and Namaqualand, which experienced good rains this year, as well as Lesotho, where the important Highlands Water Scheme is being developed, were singled out for special attention. Research on our indigenous plants is advancing on a broad front and the Institute can look back on a successful year.

ADMINISTRATION DIVISION

In June 1986, Mrs D.J. Gerber, head of the division, was transferred to the Commission for Administration on promotion. For seven months the Institute was without an administrative head and Mrs J. Rautenbach, the State Accountant, assumed the role of acting head. In January 1987, Mr J.T.C. Snyman from the Highveld Region, Potchefstroom, was appointed as head, thus finally resolving a difficult situation.

We acknowledge with gratitude the determination and loyalty of the staff which kept the Administration Division operational.

HERBARIUM DIVISION

Understaffing continues to be a major problem for the four herbaria of the Institute affecting all areas of activity, namely curation, research and the information services. It is unlikely that any meaningful relief will be forthcoming for at least another 12 months or longer.

National Herbarium, Pretoria (PRE)

Curation

Approximately 140 scientific journals were scanned for taxonomic and nomenclatural changes covering the *FSA* region. Of these 56 contained articles of direct significance to southern Africa. Statistics available for the monocotyledon families show that over 113 new names were adopted — including 77 new taxa, 27 old names re-adopted and 9 existing names new to the *FSA* region.

The updating of the PRECIS databank continued with 7 000 specimens having undergone name

changes and 4 500 specimens having had their grid reference added or corrected. Other miscellaneous changes affected 1 300 specimens.

Distribution records were significantly extended for 63 taxa, mostly at the provincial level, and include a number of new records for southern Africa.

Computerization

The Burroughs B26 multi-user computer system is proving to be a tremendous asset despite many of the applications for which it was purchased still being in the developmental stage. The most important application currently in use is the capture of specimen label data and the printing of single or multi labels for each specimen. This application alleviates the need to type long and difficult plant and author names. The system was extended during the year with the purchase of an additional 40Mb hard disc and a 60Mb tape streamer for general data backup and the storage of archival data. A link by modem to the B7900 mainframe, housing the PRECIS database, has been established with the successful down loading of data from the mainframe to the B26 system.

Accommodation

There has been no progress with the installation of three working bays on the south side of each herbarium wing or the two-room prefab building to accommodate deepfreezers and driers for decontaminating and drying specimens. These should hopefully be installed during the coming year. Another minor work also in the pipeline is a new SEM room. No new herbarium cabinets were purchased. The funds for these were used for computer equipment and dissecting microscopes. Plans to install fire protection and air conditioning in the herbarium are progressing well. This major work should commence in about June 1987.

Collecting expeditions

These included trips to the Cape — Calvinia District; Natal — Nkandla and Ngeli Forests; north-eastern OFS and western Transvaal (general collecting); Transkei — Mkambati Nature Reserve (co-operative general collecting with Botany Dept, UNITRA); southern OFS (Hepaticae and general collecting); south-western and eastern Cape; Natal and south-eastern Transvaal (Cyperaceae, Polygonaceae and general collecting); eastern Transvaal — Barberton (*Vigna* and *Ozoroa*): eastern Lesotho (Bryophyta and general collecting, Figure 1).

Research and related activities

The family Polygonaceae (G. Germishuizen). The genera *Polygonum, Bilderdykia* and *Reynoutria* have been rewritten in the new flora format and submitted to the editor. Work on *Oxygonum, Fagopyrum, Emex* and *Rumex* is nearing completion.

Studies in the genus Riccia *(Hepaticae) (S.M. Perold).* The spore ultrastructure study was completed and will be incorporated in a revision of the family Ricciaceae. Seven papers were published. Another on *R. campbelliana* Howe was submitted for publication. Papers on *R. nigrella* DC. and *R. capensis* Steph. and on two new white-scaled species are nearing completion.

Revision of Vigna *(Fabaceae) (B. J. Pienaar).* The recognition of three varieties within *V. vexillata* (L.) A. Rich. for the *Flora of tropical Africa (FTA)* region, based on calyx lobe characteristics, appears not to hold good for southern Africa. Wing sculpturing as well as SEM studies of the stigma are proving to be taxonomically useful at the species level.

Revision of Carex *(Cyperaceae) (C. Reid).* Work on this project is now well under way. Much of the field work has been completed, with herbarium and anatomical material having been collected for most

FIGURE 1. — Mr J. van Rooy examining a large stand of the low-growing grass *Polevansia rigida* in the Sani Valley in south-eastern Lesotho. Previously this grass had only been collected four times.

taxa. Fieldwork has shown that *C. drakensbergensis* and *C. cognata* are probably conspecific.

Revision of the broad-leaved species of Asclepias *(A. Nicholas).* The holdings of the tribe Asclepiadeae in seven southern African herbaria were examined and specimens selected for study. This includes two thirds of the required type specimens. 12 of the 38 taxa have been collected and photographed in the field.

Contributions to the moss flora (J. van Rooy). Work on the family Orthotrichaceae for the 3rd fascicle of Bryophyta for the *Flora of southern Africa (FSA)* is progressing well. Revisions of *Macrocoma, Cardotiella, Macromitrium* and *Schlotheimia* have been completed.

Transvaal wild flowers *(Vol. 2) (G. Germishuizen).* This work is progressing slowly with 120 plants (22% of total) having been illustrated and 40 descriptions completed.

Plant species and synonym list (various contributors). Corrections, additions and changes were made to the manuscripts of Edition 2, Part 2 (Dicotyledons). This has now been submitted for publication.

Research support

Scanning electron microscope (S.M. Perold). 2 745 micrographs were prepared for various BRI and outside workers. These include fossil leaf surfaces, Lythraceae seeds, Cucurbitaceae fruits, Polygonaceae leaves and pollen, Ericaceae pollen and seeds, *Euphorbia* leaves and seeds, Restionaceae pollen, *Vigna* leaves and inflorescences, Solanaceae leaves, *Ehrharta* leaves, *Macromitrium* leaves, Orthotrichaceae capsules, lichen thalli and *Riccia* spores and thalli.

Determination of priority collecting areas (various contributors). Efforts are under way to predict the species density per $\frac{1}{4}$° grid for southern Africa. These data will be compared with actual collecting records extracted from National Herbarium PRECIS data bank. The difference between the actual and predicted values for each $\frac{1}{4}$° grid will form the basis for assigning priorities to areas poorly represented by collections in the National Herbarium.

Expansion of collections from poorly represented areas (various contributors). Western Transvaal — holdings for four $\frac{1}{4}$° grids were increased from 18 to 329 collections; north-eastern OFS — holdings for two $\frac{1}{4}$° grids increased from 5 to 386 collections; Mkambati Reserve — holdings for three $\frac{1}{4}$° grids increased from 1 708 to 2 224 collections; Calvinia — holdings for seven $\frac{1}{4}$° grids increased from 118 to 315 collections.

Expansion of the fruit and seed collection (E. Retief). This has been contributed to largely from material collected during fieldwork for other projects. The fruit collection was extended by 346 to 4 681 collections, the seed collections by 365 to 4 368 collections.

Special collecting vehicle (M. D. Panagos). Fitting the Nissan Ekonovan as a collecting vehicle is complete. Some of the special features added are — a custom-made roofrack to house and assist in drying 12 plant presses, exterior roll-up awning attached to side over door, interior shelving system with removable plastic storage bins, large fixed bin for camping equipment, compartmentalized box for food, cooking utensils, gas bottles, detachable working surface and two-way FM radio.

Publications

29 articles appeared in local (22) as well as overseas (7) publications. A further 24 articles are in press.

Contributions to outside publications

Various members of the Division contributed to the following publications by checking the texts: La Croix — *Growing scented plants in southern Africa*; E. van Wyk — *Practical book of herbs*; A. Batten — *Flowers of southern Africa*; Courtenay-Latimer *et al.* — *Die blomplante van die Tsitsikamabos en -Seekus Nasionale Park.*

Plant identification services

20 385 specimens were identified for officers of this Institute, various State Departments, Provincial Administrations, universities and neighbouring states. In addition, identifications for 247 visitors numbered 1 176. Enquiries received by telephone totalled 1 098. New accessions to the herbarium numbered 21 235. In January 1987 a start was made using the computer to input and print specimen labels. The result is a noticeable reduction in the 12-month typing backlog.

Visitors

In addition to numerous local visitors from various universities, Government institutes, Nature Conservation etc., together with members of the general public, the herbarium was also utilized by officers and personnel from Lesotho, Botswana, Swaziland, Bophuthatswana, Venda and Transkei.

Many overseas visitors visited the Institute and Herbarium. These included Prof. D. Wiens (Utah, USA); Dr R.M. Polhill (Kew, England); Prof. O.H. Volk (Würzburg, W. Germany); Prof. and Mrs D. and U. Müller-Doblies (Berlin, W. Germany); Dr R.S. Wallace (Piscataway, USA); Dr N. Jürgens (Hamburg, W. Germany); Mrs D. Goble (Perth, Australia); Dr C. Laude (Liège, Belgium); Mr H. Breyne (Kinshasa, Zaire); Dr M.E. Hale (Washington, USA); Dr U. Meve (Münster, W. Germany); Dr K. Winter (Illinois, USA); Mr C.H. Stirton (Kew, England) and Prof. F. Sandberg (Uppsala, Sweden).

Loans and exchanges

59 loans (comprising 4 112 specimens) were sent out and 100 loans (9 718 specimens) returned. The

total number of outstanding loans is 291 (29 428 specimens). 7 955 specimens were despatched as part of exchange agreements and 3 115 were received by PRE.

Natal Herbarium, Durban (NH)

Mrs M. Jordaan continued to act as curatrix of the herbarium and officer-in-charge of the unit and was supported administratively by Mrs H. Noble. Mr A. Nicholas was transferred to the herbarum for six months (April to September) to assist Mrs Jordaan who was on leave for three months. Mr A. Ngwenya is now assisting with a large proportion of the identifications allowing senior staff to proceed with more important work. Mr C. Buthelezi, after $9\frac{1}{2}$ years of service, resigned at the end of January and his post was filled by Mr B. Ntombela.

During the last year a record 6 596 plant identifications were done (almost double the number for the previous year), 323 visitors received, 951 telephone enquiries dealt with, 294 letters written, 324 specimens sent out on loan, 3 398 specimens mounted and 3 015 specimens accessioned.

Removal of western Cape taxa continued with 593 specimens being sent to the National Herbarium, Pretoria and 389 to the Stellenbosch Herbarium. The sorting and refining of Natal taxa continued and in this connection visits were made to both the National Herbarium and the University of Natal Herbarium, Pietermaritzburg. Collecting trips were undertaken to Nkandla Forest and Nsuze Valley, Weza State Forest and the Mkambati Nature Reserve.

The Department was one of 14 recipients to receive the first conservation awards presented by the

FIGURE 2. — Mrs M. Jordaan, curatrix of the Natal Herbarium, with the certificate awarded to the Department for the conservation and maintenance of the old John Medley Wood house.

Durban City Council for the preservation and maintenance of historic buildings in the city (Figure 2). The building in question is the house built for John Medley Wood, the first Curator of the Natal Herbarium. It is built in redbrick with verandas of fine detailing, was completed in 1890 and is a fine example of a late Victorian building. It is now used as offices and also houses a unique museum containing botanical articles, photographs and equipment of historic interest.

Government Herbarium, Grahamstown (GRA)

This year has seen a number of staff changes. Mrs E. Brink continues to curate the herbarium, and Dr A. Jacot Guillarmod retired at the end of January; Mrs M.L. Furlong left at the end of November and her post was filled by Miss S.A. Olivier who joined the staff in February. Mr A. Palmer, of the Ecology Division, joined the unit in March.

Despite the upheaval caused by these changes the unit continued to function efficiently with 1 754 specimens being identified, 822 visitors received, 484 telephone enquiries answered, 1 577 specimens mounted, 1 437 specimens accessioned, 48 specimens sent out on loan and 118 specimens sent out as exchanges. A function peculiar to GRA is the arrangement of displays, mainly for the Albany Museum, of which 57 were set up this past year.

The scanning and sorting of specimens continued in order to rename misidentified specimens. In the process more homogeneous taxa are created within the cupboards. In this connection, 229 genera involving some 2 400 specimens were examined.

Mrs R. Hart, who occupies a part-time post funded by the Pocock Bequest to the Albany Museum, continued the work of curating the Pocock Marine Algae collection. The Unit is indebted to Mr N. Abrahams for his continued assistance in the herbarium in a voluntary capacity as well as to Dr Jacot Guillarmod since her retirement date.

Three collecting trips were undertaken this year, the most important being a three week trip to South West Africa/Namibia by Dr Jacot Guillarmod.

The block clearing of alien plants on the Grahamstown Nature Reserve remains an endless problem and work has continued throughout the year. Mrs Brink visited the reserve 78 times during the year to carry out routine inspections and to consult with the reserve manager.

Government Herbarium, Stellenbosch (STE)

Mr R.O. Moffett, the former curator, resigned in July to take up a lecturing post at the University of the North, QwaQwa Branch. Miss P. Burger took up his post until her transfer to the Wine Research Institute in January. Since February the post of curator has been filled by Mr E.G.H. Oliver. Mrs J.B.A. Beyers joined the staff in February. Due to the modernization of the Natural Sciences Building by the University of Stellenbosch, the unit had to vacate its accommodation at the end of September. The herbarium is now housed in the old Carnegie Library (where it is likely to stay for some time). The move allowed staff to re-organize the herbarium layout and service room procedures.

Despite a rather unsettled year, services and curatorial activities were maintained at a high level with 4 039 specimens being identified, 229 visitors and 3 groups of students received, 210 telephone enquiries answered. 117 letters written, 989 specimens sent out on loan and 6 463 specimens accessioned.

Collecting trips were undertaken to an area north of Calvinia (undercollected quarter degree squares as gauged from PRECIS printouts), to the northern slopes of the Langeberg near Barrydale (staff accompanied Mr D. McDonald of the BRI Ecology Division), and several short weekend trips were made during the spring months. It was on one of these weekend trips that the new species, *Romulea unifolia* De Vos, was collected. Mr Oliver also represented the herbarium at the Herbarium Curators Meeting held in Pretoria in November.

Mr Oliver continued his work in the Ericaceae. Research was centred on the four minor ericaceous genera: *Acrostemon, Syndesmanthus, Thoracosperma* and *Simocheilus.* As part of this work, the pan-African genera *Philippia* and *Blaeria* were sunk under *Erica,* making it a genus of some 650 species in southern Africa.

FLORA RESEARCH DIVISION

Flora of southern Africa (FSA)

The *FSA* subproject has continued to have impact outside the Institute in several ways. There are about 190 potential contributors to the *FSA,* the majority of whom are overseas specialists in their plant groups. Thus, the *FSA* helps to maintain scientific contacts with other countries. The Department continued the research contract with the University of Cape Town, for the Orchidaceae volume, with Prof. A.V. Hall leading the research. The fifth meeting of the *FSA* working group was held during the congress of the South African Association of Botanists at Durban in January 1987. News of interest to *FSA* contributors was circulated in *Forum Botanicum,* the newsletter of SAAB.

Two *Flora* fascicles were published, Pteridophyta, by the late Prof. E.A. Schelpe & N.C. Anthony, covers 28 families, 74 genera and 275 species of ferns. Volume 18,3 covers the families Simaroubaceae (by K.L. Immelman of the BRI), Burseraceae (by Prof. J.J.A. van der Walt of Stellenbosch University), Ptaeroxylaceae and Meliaceae by (F. White & B.T. Styles of Oxford University and Malpighiaceae (by P.D. de Villiers & D.J. Botha of Potchefstroom University and K.L. Immelman), and includes 13 genera and 131 species. To date, the total number of species treated in published parts of the *FSA* is 2 790, which amounts to 12,7% of the total of 22 000 species in the southern African flora.

The *List of species of southern African plants,* edn 2, part 2, covering dicots, is in press. The *List of species* is a precursor to the *FSA* that presents up-to-date coverage of all taxa at increasing levels of ap-

proximation. Edition 2 includes for each genus the name and author, the current reviser and the literature necessary to identify specimens to species and to determine important synonymy; and for each species the name and authors of currently accepted names and of important synonyms since the completion of *Flora capensis* are given. During this time, about 12 000 commonly used names have gone into synonymy for our 24 000 taxa. Future editions will contain additional species information, such as distribution, conservation status and life form.

Institute staff members, and outside contributors on contract made the following progress with volumes and fascicles for the *FSA*:

Bryophyta: The genus *Bryum* was completed by Mr J. van Rooy, and Fascicle 2 of the treatment of mosses, by Dr R.E. Magill of the Missouri Botanical Garden, has gone to press. Work is now well under way for the third fascicle on mosses by Dr Magill and Mr van Rooy.

Vol. 2: Poaceae — Oryzoideae, Centostecoideae and Bambusoideae. A paper by Dr G.E. Gibbs Russell and Dr R.P. Ellis, 'Species groups in *Ehrharta* of southern Africa' was presented in July 1986 at the International Symposium on Grass Systematics and Evolution at the Smithsonian Institution, Washington, D.C., which was atended by both these officers. Species-level data for Ehrharteae is being entered in the DELTA computer system for comparative descriptive information. Details of this new approach are covered in the Data Subdivision report.

Vol. 5: Liliaceae — Aloinae–*Aloe*. The *FSA* manuscript for *Aloe* by Dr H.F. Glen and Mr D.S. Hardy is completed. Dr Glen, assisted by Mrs S.M. Perold, has examined all southern African species for leaf epidermal types using the scanning electron microscope. Six papers supporting or extending the *FSA* manuscript have been prepared, and several more are expected. A paper describing variation in *A. dichotoma* was read at the SAAB Annual Congress in January 1987 by Dr Glen.

Vol. 5: Liliaceae — Asparagoideae. Miss K.L. Immelman is finalizing the manuscript and reviewing the keys for *Protasparagus* and *Myrsiphyllum* left incomplete on the retirement of Mrs A.A. Mauve (Obermeyer).

Vol. 8: Orchidaceae. Prof A.V. Hall, is University Contractor for this volume, and Dr H.P. Linder, formerly of the BRI but now on the staff of the University of Cape Town, is co-operating. A student, Mr T. Gericke, has been employed to work on the 65 species in 17 genera that still require attention. So far 46 species in 7 genera have been completed, and about 100 species completed in past years have been re-written in the new *FSA* format.

Vol. 9: Salicaceae, Fagaceae, Urticaceae and Piperaceae. *FSA* manuscripts have been prepared by Miss Immelman for all genera, and the Urticaceae awaits final alterations by the collaborator, Dr I. Friis of the Botanical Museum and Herbarium, Copenhagen.

Vol. 11: Mesembryanthemaceae. A treatment of *Astridia, Acrodon* and *Ebracteola* was published in *Bothalia* 16, 2 by Dr Glen.

Vol. 16: Fabaceae. Mr B.D. Schrire's account of the tribe Desmodieae, as well as a conspectus of *Tephrosia* subgenus *Barbistyla* in the tribe Millettieae, are in press in *Bothalia.* Mr Schrire has been designated world co-ordinator for the tribe Indigoferae for the ILDIS (International Leguminosae Database and Information Service) project being initiated from the University of Southampton. In July 1986, Mr Schrire attended the conference on 'The biology of the Leguminosae' held at the Missouri Botanical Garden, St Louis, USA, and delivered a paper, 'Floral biology of the Leguminosae'.

Vol. 23: Lythraceae. Miss Immelman has begun the *FSA* treatment of this family, to complement research being done in Myrtales by contributors to the *FSA* outside the BRI. Preliminary taxon concepts and trial keys are being developed.

Vol. 25: Ericaceae. Mr E.G.H. Oliver has continued studies in the 'minor genera', concentrating on the last complex of four minor genera in the Ericoideae. A major step taken was the inclusion of the pan-African genera *Philippia* and *Blaeria* within *Erica,* making it a genus of 650 species in southern Africa.

Vol. 30: Acanthaceae — *Justicia.* Miss Immelman's completed *FSA* manuscript is with the editor, and awaits contributions from researchers from other institutions before the fascicle can be published.

Pretoria Flora

Dr O.A. Leistner constructed keys to the 141 plant families in the Pretoria area, using 295 couplets designed to be easily distinguishable. Trees, ferns, water plants and parasitic plants were specially treated, using vegetative keys. The *Pretoria Flora* will cover about 1 780 species, and only about 100 are still outstanding.

Palaeoflora of southern Africa

Drs J.M. Anderson and H.M. Anderson are now preparing the second volume in the Molteno Formation series, dealing with all the 22 genera and 88 species of gymnosperms (except *Dicroidium,* which was published in Volume 1). This work is a review of 75 assemblages plus all published information from the Gondwana Triassic Realm, and includes plates, figures, maps and tables, as well as detailed cuticular analyses, which revealed much new and unexpected data relevant to taxonomy, classification and palaeoecology. The study has led to new insights into speciation processes, diversity trends and phytogeography of Gondwanaland (Figure 3).

Liaison Officer, Kew

Mr Schrire is in his second year of duty as South African Liaison Officer. He has continued to provide information about taxonomic and related subjects to researchers on the southern African flora, and to pursue his research in Fabaceae, which is

FIGURE 3. — Molteno Formation (Upper Triassic, ± 200 million years old). Upper Umkomaas fossil plant locality, perhaps the most famous and productive locality in South Africa.

detailed above. He privately visited the herbarium at Trinity College in Dublin where most of Harvey's specimens for the early volumes of *Flora capensis* are housed, but are in desperate need of modern study.

Exhibition of botanical art

A second exhibition of botanical art by the Botanical Research Institute was held in the Pretoria Art Museum from 4 – 22 March 1987 (Figure 4). This time over 200 water colour paintings plus numerous pen drawings were exhibited representing the work of 11 artists over the last 14 years. All the studies exhibited were executed for the Institute's several publications. The exhibition, which was very well attended, was opened by Dr R.J. van Niekerk, Director of the Directorate of Agricultural Information, Department of Agriculture and Water Supply.

Miss G. Condy was responsible for the mounting of the plates for display, the arrangement of the display, the production of a catalogue and advertising the exhibition in the press and radio.

DATA SUBDIVISION

The subdivision coordinates the computer work of the Institute. Two large systems maintained on the B7900 mainframe are the taxonomic database PRECIS and the ecological database PHYTOTAB. Links are maintained to IBM mainframes for the library (SABINET), the ecological bibliography and for typesetting. Several divisions now operate their own microcomputers: the Hewlett-Packard 9845B was taken over by Vegetation Ecology; Herbarium and Flora Research share a Burroughs 26 network linked to the B7900 mainframe; Plant Structure and Function has 2 Olivetti PC's, and the Experimental Ecology Division in Cape Town and the Stellenbosch Unit each have IBM PC's.

PRECIS is managed by Mrs J.C. Mogford, and now consists of four components. Specimen-PRECIS contains herbarium specimen label data in 24 data fields for 630 000 specimens in PRE herbarium; taxon-PRECIS contains recent useful literature, synonymy, status as naturalized alien, and status of current taxonomic research for the 24 000 plant taxa in

FIGURE 4. — The exhibition of botanical art from the BRI held in the Pretoria Art Museum in March 1987.

southern Africa; nomenclature-PRECIS has begun as a prototype for Poaceae, to be developed further when staff is available; and curatorial-PRECIS is to be developed on a Burroughs 26 microcomputer network to link information from specimen-PRECIS to the curatorial and administrative needs of Herbarium Division. Mrs Mogford presented a paper at the SAAB Congress on the specimen component of PRECIS.

PHYTOTAB, managed by Mr M.D. Panagos, now includes 48 published ecological surveys and field data sets. Vegetative keys are in continuous development for plants of the Waterberg, and Miss B. Turner presented a paper at the Annual Congress of SAAB on her vegetative key to grasses of the Amersfoort area. Mrs B.C. de Wet is expanding the PHYTOTAB programs.

Smaller systems being developed further on the B7900 include the Garden Records system, developed by Mrs B.C. de Wet, for data about all the plants in the botanical garden, and PHOTOS, developed by Miss A.P. Backer to record data about photographic vegetation records for Vegetation Ecology Division.

Dr Gibbs Russell spent several weeks in October and November 1986 as a Research Fellow at the Taxonomy Unit, Research School of Biological Sciences, Australian National University, Canberra, learning the DELTA system for recording comparative descriptive characters to assist in data manipulation for classification, and for generation of descriptions, keys and online identification aids. DELTA is now in operation on the VAX 11/750 minicomputer at the Soils and Irrigation Research Institute. Keys and descriptions to all southern African grass genera, and to species in the grass tribe Ehrharteae are being developed.

PLANT STRUCTURE AND FUNCTION DIVISION

Dr R.P. Ellis attended the International Symposium on Grass Systematics and Evolution in Washington D.C. in July, 1986. He presented a paper on the contribution of grass leaf blade anatomy to the systematics of the Poaceae and co-authored a paper proposing a new arrangement of bamboo genera into tribes and subtribes.

Comparative anatomy

For the proceedings of the Grass Systematics and Evolution meeting Dr Ellis prepared a review, with an extensive bibliography on the contribution of comparative leaf blade anatomy to the systematics of the Poaceae over the past twenty five years. This paper highlights those taxonomic groups most in need of anatomical study and shows that priority should be given to the core Bambusoideae, the Paniceae, the Centotheceae and the Ehrharteae.

Cytogenetics

The cytogenetical studies on the South African grasses being undertaken by Dr J.J. Spies are progressing well with chromosome numbers of over 100 plants having been determined (Figure 5). He has also shown that the genus *Hyparrhenia* has a lower basic chromosome number than is generally accepted and that hybridization occurs on a large scale in this genus. These results once again emphasize the importance of cytogenetics as a basic requirement for taxonomy, breeding and other applied studies.

Wood anatomy

Mr P.P.J. Herman continued with his wood anatomical studies and paid particular attention to the Proteaceae. This work is still in the initial stages but early indications are that the vessels and paratracheal parenchyma may prove to be useful taxonomically.

Mary Gunn Library

Mrs E. Potgieter and Mrs B.F. Lategan have had a very busy year as the demand for services from the Mary Gunn Library continues to increase. A total of

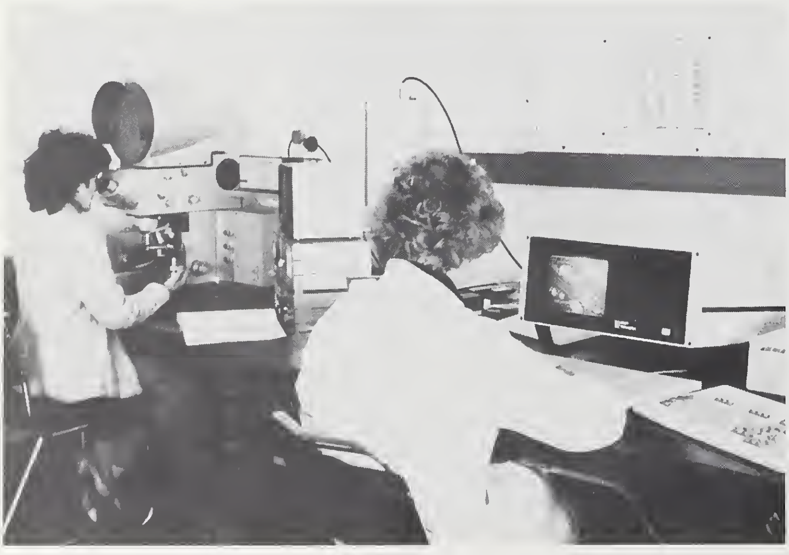

FIGURE 5. — Photo-microscope with television camera image analyser in operation in the cytogenetics laboratory. This equipment enables quantitative structural data for caryotype studies to be analysed and evaluated.

1 743 books and journals were borrowed, 2 136 inter library loans were handled, 2 645 enquiries dealt with, 20 671 photocopies made and 390 volumes were bound. About 60 old and valuable reference volumes were re-bound in leather with money made available from the Flowering Plants of Africa Fund. During the year, 202 new books were acquired in addition to the 364 journal titles to which the Institute subscribes. An important event was the linking of the library computer to the South African Bibliographic and Information Network (SABINET) system which has streamlined many administrative tasks such as the cataloguing of new accessions.

VEGETATION ECOLOGY DIVISION

The functions of the Vegetation Ecology Division under Dr J.C. Scheepers are to study the vegetation of South Africa and its ecological relations. This work involves three main aspects: the identification, description, classification and mapping of the various kinds of vegetation; study of the ecological relationships between different kinds of vegetation — with one another and with the environment — and of the various processes and mechanisms that determine the behaviour of plant communities; and the application of such ecological knowledge to the management and utilization of vegetational resources.

Transvaal bushveld and forest studies

Mr R.H. Westfall is studying the vegetation ecology of the Sour Bushveld in the Transvaal Waterberg. Thirty-two stands representing six different vegetation types have been sampled. Initial results indicate that the main environmental gradient responsible for the differentiation is moisture availability which correlates with parameters such as soil depth, soil texture, slope, aspect and exposure in combination for a given rainfall. The results also indicate sites best suited for cultivation in terms of available moisture.

The investigation of the implications and applications of Mr G.B. Deall's research on the vegetation of the Sabie area of the eastern escarpment are continuing. Ordination of Land Type-labelled vegetation samples reveals that floristic differentiation is often not correlated with Land Type delineation. Therefore, the use of Land Type *per se* for vegetation delineation is inappropriate. Land Types may be useful, however, for delineating broad Landscape classes derived in conjunction with an *a priori* floristic classification. Field testing of such a scheme showed it to be approximately 65 and 75 per cent accurate with respect to interpolation and extrapolation respectively. Land Types thus offer considerable potential for the mapping of extensive areas at the Landscape level, where biotic and abiotic criteria can be considered together.

Coastal studies

The conservation priorities in the Kosi Bay – Sodwana area were provisionally mapped and a report on conservation priorities was written up by Dr P.J. Weisser. Areas worthy of protection are mainly situated along the coast, near the Sibayi Lake and north of Sodwana. Other manuscripts are in various stages of preparation and finality.

Mr M.G. O'Callaghan is rounding off follow-up work on Cape estuaries and publication of results is continuing. The sampling of dominant plants around 53 Cape estuaries was completed this year. Two basic salt marsh communities were found, with salinity and regularity of tidal inundation as major controlling factors. The first is dominated by perennial herbs and shrubs, mainly Chenopodiaceae and Juncaginaceae. The second is dominated by sedges, usually *Juncus* with numerous ephemerals and annual herbs (mostly Asteraceae) appearing at various times. Two further vegetation types were recognized, although they are not salt marshes: submerged aquatics (Ruppiaceae, Zosteraceae and Potamogetonaceae) and emergents (*Scirpus* and *Phragmites*).

Cape fynbos studies

Research on the mountain fynbos in the Cederberg by Mr H.C. Taylor is well under way (Figure 6). In this field phase of the programme, 84 relevés in the northern sector revealed 14 or 15 putative community types, and a further four or five types were found in 22 relevés in the central sector. A series of nested quadrats in thicket showed that a plot size of 200 m^2 will record 57% of the species predicted to occur on 1 ha in this coarser-patterned vegetation. Two hundred and eighty herbarium specimens were collected and a check list of the total flora of the Cederberg is halfway to completion.

In the ecological study of mountain fynbos and other vegetation of the Langeberg, Mr D.J. McDonald has completed 124 relevés along the first transect. Of these, 119 sampled Mountain Fynbos vegetation and five Afromontane Forest vegetation. Preliminary classification of 72 relevés using the computer program TWINSPAN has resulted in 13 distinct 'groups'. Futher analysis using the program DECORANA shows that the 'groups' are distributed along the transect primarily in response to moisture regime and secondarily to changes in geology.

Grassland studies

Field sampling of the grassland vegetation of the Amersfoort area of the eastern Transvaal Highveld by Miss B.J. Turner is nearing completion. The data will be used to classify the vegetation into different communities with a view to establishing a predictive system of vegetation–environment relationships of wide extrapolatability.

EXPERIMENTAL ECOLOGY DIVISION

The division, under Dr M.C. Rutherford, moved into its new consolidated quarters in the Botany Building of the University of Cape Town in 1986. Nursery facilities were also expanded by members of the division to satisfy the need to test a greater range

FIGURE 6. — Restioid Fynbos near the Wolfberg Arch, Cederberg, Cape.

of field-generated hypotheses under more controlled conditions. Various members of the division have participated and contributed to several symposia, workshops and conferences within the co-operative Fynbos and Karoo Biome Projects. The division's research has continued to concentrate on the disturbance of indigenous plants through alien invasive plant competition and by substrate disturbance in the Fynbos Biome and on plant–water relations in the Succulent Karoo Biome. Within the context of the study of alien–indigenous plant interactions, three members of the division contributed a chapter on growth rates and resource use efficiency in alien plant-invaded ecosystems to the important synthesis volume on the ecology and management of biological invasions in southern Africa. Also, on a subcontinental scale, the research on the determination of southern African biomes culminated in the publication of the results as *Memoirs of the Botanical Survey of South Africa* No. 54 (1986).

Fynbos reproductive ecology

Dr C.F. Musil has found a higher species diversity and density of buried viable seeds in soils taken from recently burnt than from unburnt fynbos communities. However, species richness of buried, viable seed was low compared with that of the above-ground plants. Laboratory studies confirmed that exposure of some fynbos seeds to heat enhanced their subsequent germination. An increase in heat intensity had a greater effect on subsequent germination than duration of exposure at a given intensity. Viable seed distribution in fynbos soils studied has been found to be highly clumped, possibly indicating restricted seed dispersal.

Miss F.M. Pressinger has completed her studies on the germination of *Protea repens* and a paper on the results is being prepared for publication.

Fynbos – alien invasive plant interactions

Dr M.C. Rutherford, together with Mr J. de W. Bösenberg, have established that the effect of the alien invasive *Acacia cyclops* in the western Cape is markedly species dependent. Statistical analyses show that, although many indigenous species are negatively associated (amensal, for example, *Eriocephalus racemosus*) with solitary, well established *Acacia cyclops* individuals, many are relatively neutral (for example, *Euclea racemosa*) and some are even positively associated (commensal) with this level of *Acacia cyclops* infestation. Several of these commensals are annual species, for example, *Cysticapnos vesicarius.* Water stress response (in terms of xylem pressure potentials) to the *Acacia cyclops* areas varies and may depend on the age of the alien plant. For example, water stress in *Euclea racemosa* appears reduced under younger *Acacia cyclops* but increased under older *A. cyclops.* The effects of changes in radiation, nutrients, and various ecophysiological parameters on the presence, abundance and certain morphological aspects of the indigenous plants is being further investigated.

Miss Pressinger's studies have confirmed that at the seedling stage, the presence of *Acacia saligna* grown in close proximity to the indigenous *Protea repens* did not affect the growth of mortality rate of *P. repens.* Further work will investigate this interaction with older plants in their natural habitat.

Fynbos tranformation studies

Mountain fynbos soil which had been cleared by burning and then rotivated, has been monitored by Mr G.W. Davis together with Mr A.P. Flynn with regard to re-establishment of the natural plant community. The abundance of the species most frequently found on the study site, as well as the overall

species richness, was shown to be reduced by the treatment. On the other hand, above-ground biomass production of the dominant species was found to increase with the treatment, and summer measurement of water status of these species indicated that they experienced less stress on disturbed soil than on undisturbed soil.

Plant water relations in Karoo

Mr G.F. Midgley has concentrated on studying soil water availability relative to aspects of water relations and growth in several Karoo plant growth forms. Low soil moisture levels during summer correlated with measures of plant water stress, leaf shedding and shoot dormancy in non-succulent growth forms. Leaf production occurred during winter and spring when soil water availability and shoot water potentials increased. Growth patterns of succulents were similar. During summer, the leaf succulent *Ruschia caroli* experienced heat stress. However, the vertical orientation of the succulent stems of *Euphorbia mauritanica* and *E. burmannii* appear to minimize heat stress and consequent water loss by minimizing light interception.

PLANT EXPLORATION DIVISION

The division, under Mr M.J. Wells, continued to concentrate on weeds, plant invaders and food plant research, but also co-operated in research on plant causes of dermatitis. Mr T.H. Arnold continued to lead the food plant research team from his position as head of the Herbarium Division. Highlights were the publication of the *Catalogue of problem plants of southern Africa* and the development of the garden utilization activity.

Conservation of germ plasm

This was a year of consolidation for technicians Miss A.E. Swanepoel and Mrs L.D. Jacobs. Only one collecting trip was made and 15 seed samples collected but 3 000 samples of previously collected material were split for distribution, labelled, packaged, indexed and stored in two newly acquired chest freezers. Primitive crop seed samples, 704 in all, were distributed to researchers and seed banks in Argentina, South Africa and the USA. Seed of food plants from the veld went to a number of development agencies in South Africa and to Israel. About 170 seed samples as well as vegetative material of indigenous species, were collected in the garden by Mrs H. Joffe, to encourage their use and further propagation by local nurserymen. A chest freezer has also been acquired for storage of garden seed. Whilst chest freezers can be used to extend the life of seeds this is still a relatively short term solution to the problem of safeguarding germ plasm. However, unless seed is regrown on a regular basis the future of taxa cannot be assured.

Indigenous food plants

Mr A.A. Balsinhas abstracted information from 48 publications, bringing the references consulted for the national food plants data bank to a total of 217. The newly consulted references contributed information about 602 species and resulted in the addition of 20 new names to the list of food plants, which now includes 1 609 species.

Miss S.E. Chadwick has compiled dossiers on 14 priority food plants of the veld, including 18 more references, bringing the total to 634. She completed reports synthesizing the contents of dossiers on *Cucumis metuliferus, Acanthosicyos horridus* and *Cucumis kalahariensis,* to add to the two previously completed *(Bauhinia petersiana* and *Coccinia adoensis).* The report on *Guibourtia coleosperma* is nearly complete. A separate report entitled 'The cucurbitacins' has also been prepared, to bring all the relevant information together and to obviate repetition in the 10 cucurbit dossiers. It is of interest that only 5% of certain cucurbit fruits encountered in the central Kalahari were bitter, whereas the same species tested in South West Africa/Namibia yielded 81% bitter fruits. Some of the species being researched are obvious candidates for development and there is widespread interest in their potentials.

Primitive crop plants of African origin

The morphological characteristics of 753 *Sorghum* collections were analysed, bringing the total number

FIGURE 7. — The succulent *Euphorbia* spp. are often used by rural peoples in southern Africa as barrier plants. Illustrated here is the tree Euphorbia, *Euphorbia ingens*. Cuttings of this species as well as plants of an alien *Agave* sp. have been used to fill in the lower gaps of the barrier.

analysed to 1 277. Seed colour measurements were carried out on 687 collections, bringing the total measured to 1 837. The chlorox test for tannin content was applied to 760 samples, bringing the total to 1 010 samples tested. The technical work was carried out firstly by Miss Swanepoel and later by Mrs Jacobs, under the direction of Mr Arnold. 90% of the *Sorghum* material so far collected has now been processed. The next stage of the work will involve collecting in Kwa Ndebele, computer analysis of the *Sorghum* data, and a start on recording data from the large number of *Pennisetum* collections that have already been made.

Barrier plants

The survey of barrier plants by Miss L. Henderson, who is on the staff of the Plant Protection Research Institute, is in press, and will appear shortly as *Memoirs of the Botanical Survey of South Africa* No. 55 (Figure 7).

Woody invaders

The popular version of Miss Henderson's survey of woody plant invaders of the Transvaal is in press. She and Mr Wells also completed a chapter on alien plant invasions in the grassland and savanna biomes.

Catalogue of problem plants

The catalogue appeared as No. 53 in the *Memoirs of the Botanical Survey of South Africa* series. It is hoped that its appearance will not only aid in the planning of research, control and legislation, but that it will also generate interest in problem plants and result in more data being gathered. It appears to be having this effect, and since its appearance 50–60 'new' or newly recognized alien invader plants have been brought to our attention.

Data collected for the catalogue have also been used in the compilation of a chapter on the history of introduction of alien plant invaders, for 'the Ecology and management of biological invasions in southern Africa', which appeared recently. Mr Wells is continuing to research this subject and would value any early references to plant introductions.

Declared weeds and invader plants

A publication on declared weeds and invader plants, prepared by Mrs D.M.C. Fourie and coworkers is in press. It will enable members of the public and law enforcement officers to identify species covered by the latest legislation. The Directorate of Soil Protection who are responsible for the act (No. 43 of 1983) have also been provided with new records of species that should be considered for proclamation.

Water conservation gardening

Public interest in gardening under drought conditions continues, and Mrs Fourie is in demand to lecture on the subject.

Garden utilization

In addition to seed for propagative purposes, Mrs Joffe also collected 30 seed samples and 190 samples of vegetative material requested by various researchers, for illustration, educational or display purposes. Sixty seed and fruit collections were cleaned and prepared for the herbarium carpological collection. In all, 1 095 colour slides were taken of various parts or developmental stages of plants in the garden. These were supported by 180 herbarium specimens. Research staff were assisted with finding or monitoring progress of garden collections. Garden staff were also assisted with germination experiments and garden records staff with identification of unlabelled specimens. Utilization of the garden by the public also received attention in the form of a new map and brochure which are nearing completion.

Scientific information service

Mrs Fourie handled 263 written and 299 telephonic requests for material and information, and dealt with 49 individual visitors and 8 groups. She also obtained collecting permits from various authorities for both visitors and Institute staff.

Liaison service

In the absence of a liaison officer, no facilities could be offered to touring school groups but Mrs Fourie provided or arranged lectures and/or tours for teachers, trainee teachers and a few special interest groups.

PRETORIA NATIONAL BOTANICAL GARDEN

The accent in garden development, under the direction of Mr D.H. Dry, was on the provision of service facilities and public amenities. Mr L.C. Steenkamp, a stalwart despite his 71 years, supervised the paving of 858 metres of service roads and 413 metres of pathways. The pathways are an expansion of the system of nature trails that enjoys ever increasing popularity with the public. Trees alongside the nature trails have been provided with additional labels that include the national tree number and common name. Fourteen new benches have been placed at strategic points. Major repairs and improvements included re-sealing a large garden pond as well as the roof of the main glasshouse, and refurbishing an outhouse to provide an under-cover research facility in the experimental garden.

Mrs K. Clarke accessioned 439 additions to the living plant collection, of which over 100 were collected by garden staff during an expedition to Namaqualand in late September 1986. Mr D.S. Hardy completed planting and landscaping the SWA/Namibia house (Figure 8), and continued to assist Dr H. Glen with a taxonomic revision of the genus *Aloe*.

BIOSYSTEMATICS DIVISION

At present this division, with an effective staff of three, devotes itself largely to the scientific and technical editing of the publications of the Institute. Dr O.A. Leistner is in control of the division, Mrs E.P. du Plessis assists with the editing of *Flora of southern Africa* and *Flowering Plants of Africa* and does most of the translations from English to Afrikaans re-

quired by the Institute, and Mrs B.A. Momberg is responsible for the technical editing of *Bothalia* and *Memoirs of the Botanical Survey of South Africa*. Camera-ready copy of certain publications was produced and it is hoped to increase activities in this field in future.

Bothalia

Numbers 1 and 2 of Vol. 16 and the index to Vol. 15 were produced. This pattern of publication will be continued in future and the two numbers produced each year will be considered as constituting one volume.

Vol. 17,1 is in press and 17,2 is due to go to the printers soon. The index to Vol. 16 has gone to press.

Flora of southern Africa (FSA)

One volume and one part were published (See Flora Research Division).

The volume Bryophyta 1,2 is in press. The fascicle on the genus *Aspalathus* by the late Prof. Rolf Dahlgren (Vol. 16,3,6) is being prepared for publication.

The Flowering Plants of Africa (FPA)/Die Blomplante van Afrika

Vol. 49,1 & 2 was published and 49,3 & 4 is in press. Translations for the Afrikaans version were checked or done by Mrs E.P. du Plessis.

Memoirs of the Botanical Survey of South Africa

All numbers of this series were again produced in camera-ready form. The following were published:

FIGURE 8. — A view of the rare and endangered plant collection in the SWA/Namibia house, which is arranged according to the geographical distribution of the plants.

No. 52 *A plant ecological bibliography and thesaurus for southern Africa up to 1975* (A.P. Backer *et al.*); No. 53 *A catalogue of problem plants in southern Africa incorporating the National Weed List of South Africa* (M.J. Wells *et al.*); No. 54 *Biomes of southern Africa – an objective categorization* (M.C. Rutherford & R.H. Westfall).

No. 55 *Barrier plants of southern Africa* (L. Henderson) is expected from the printer any day, and No. 56 *List of species of southern African plants* edn 2, part 2 is in press. No. 57, a third edition of Acocks's *Veld types of South Africa,* is at an advanced stage of preparation.

Palaeoflora of southern Africa

Most of the text of Volume 2 of the Molteno Formation series has been prepared in camera-ready form.

The National List of Trees

The third, revised and enlarged edition of this work by B. de Winter, J. Vahrmeijer and F. von Breitenbach was checked. It is in page-proof stage.

BOTANICAL RESEARCH INSTITUTE

Scientific, Technical and Administrative Staff

(31st March 1987)

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Deputy Director

D. J. B. Killick, M.Sc., Ph.D., F.L.S. (General taxonomy; nomenclature; mountain ecology and editing)

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- Senior Provisioning Administration Clerks ..... Mrs I. A. Ebersohn; Miss W. J. Geldenhuys; Mrs S. Swanepoel; Mrs J. J. van Niekerk, B.A. (Ed.)
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- Agricultural Researchers A. Nicholas, M.Sc. (Asclepiadaceae); Miss K. L. Immelman, M.Sc.**

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**Part-time

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Herbarium Assistant	Mrs J. L. M. Grobler*

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Typist	Mrs C. M. Havenga
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Agricultural Researchers	Miss K. L. Immelman, M.Sc. (Taxonomy, especially Acanthaceae, Lythraceae, Urticaceae) B. D. Schrire, M.Sc. (Taxonomy of Fabaceae; electronic data processing)

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Mrs H. von Rönge (New specimen encoder for PRECIS)

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Senior Agricultural Researchers .... A.R. Palmer, M.Sc. (Karoo ecology; remote sensing; nature conservation; vegetation mapping)
H.C. Taylor, M.Sc. (Mountain fynbos and forest ecology; Braun-Blanquet approach and techniques; conservation)
P.J. Weisser, Ph.D. (Forest ecology; air-photo interpretation and mapping; reedswamp ecology; Zululand coast dune vegetation; conservation)
R.H. Westfall, M.Sc. (Ecology and phytosociology of Transvaal bushveld; ecological data and literature storage, retrieval and processing; syntaxonomic nomenclature)

*Half-day
**Biometry and Datametrics
†Library Services, Department of National Education

Agricultural Researchers. G.B. Deall, M.Sc. (Vegetation ecology of forest/woodland/grassland interrelationships)
D.J. McDonald, M.Sc. (Mountain fynbos ecology and phytosociology; Braun-Blanquet approach and techniques)
M.G. O'Callaghan, M.Sc. (Estuarine ecology and phytosociology; land-use planning and management; nature conservation)

Assistant Agricultural Researchers............... P.J.J. Breytenbach, B.Sc. Hons (Grassland ecology; pasture science; nature conservation)
Miss B.J. Turner, B.Sc. Hons (Grassland ecology; pasture science; nature conservation)

Senior Agricultural Research Technicians... Miss A.P. Backer, B.Sc. (Ecological data processing and presentation; ecological literature; nature conservation; air-photo interpretation and cartography)
M.C. Panagos, N. Dipl. Agric. (Bot. Res.) (Computer science; data processing; sampling and monitoring vegetation and environment)
J.F. van Blerk, B.Sc. (Succulent Karoo ecology; ecological literature; pasture science; photography)
Mrs B.J. Vermeulen, B.Sc. For. (Nat. Cons.) (Ecological data banking; information systems; syntaxonomic nomenclature)

Agricultural Research Technicians............... Miss M. Morley, B.Sc. Agric. (Ecological data processing and presentation; ecological literature; estuarine and fynbos vegetation; air-photo interpretation and cartography)
Miss S. van Eeden, B.Sc. (Ecological data processing and presentation; ecological literature; nature conservation; air-photo interpretation and cartography)
C.M. van Ginkel, N.Dipl. (Nat. Cons.) (Karoo ecology; nature conservation; photography)

Agricultural Research Assistant................... Mrs H.M. Hills, T.H.E.D.

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Assistant Director.......... M.C. Rutherford, M.Sc. Ph.D., Dipl. Datamet. (Primary production ecology of terrestrial ecosystems; experimental ecological studies in Fynbos and Karoo)

Senior Agricultural Researcher................ C.F. Musil, M.Sc., Ph.D. (Reproductive ecophysiology in Fynbos)

Agricultural Researcher................ Miss F.M. Pressinger, B.Sc. Hons (Ecophysiological studies of competitive stress in Fynbos ecosystems)

Assistant Agricultural Researchers.............. G.W. Davis, M.Sc. (Transformations of Fynbos ecosystems by the wild flower picking industry)
G.F. Midgley, B.Sc. Hons (Plant water relations in Karoo ecosystems)

Agricultural Research Technicians.............. A.P. Flynn, B.Sc. (Fynbos ecology; plant community development)
J. de W. Bösenberg, B.Sc. Hons (Karoo

	and Fynbos ecology; monitoring effects of alien plants on Fynbos)
Agricultural Research Assistant ...	D.M. de Witt (Laboratory, field and curatorial assistance)

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Assistant Director ...	M.J. Wells, M.Sc. (Weeds research, botanical horticulture, Fynbos utilization and conservation)
Senior Agricultural Researcher ...	Miss L. Henderson, † B.Sc. Hons (Cover and barrier plants, and exotic invaders)
Assistant Agricultural Researcher ...	Miss S.E. Chadwick, B.Sc. Hons (Indigenous food plants and primitive crops)
Chief Agricultural Research Technician ...	Mrs D.M.C. Fourie*, B.Sc. (Scientific information service)
Agricultural Research Technicians ...	A.A. Balsinhas** (Indigenous food plant data bank) Mrs L.D. Jacobs, B.Sc. Hons (Crop plants of African origin) Mrs H. Joffe*, B.Sc. (Garden utilization)

PRETORIA NATIONAL BOTANICAL GARDEN

Chief Agricultural Research Technician (Curator) ...	D.H. Dry, NTC Dip. (Hort.)
First Agricultural Research Technician ...	D.S. Hardy, (Nursery supervision, succulents and orchids)
Pupil Agricultural Research Technicians ..	D.J.F. Strydom, NTC Dip. (Hort.), Dip. Rec. P.A. N.A. Klapwijk (Supervision southern section of garden) N.F. van Zyl (Supervision northern section of garden)
Agricultural Research Assistant ...	Mrs K. Clarke (Garden records)
Farm Foremen ...	L.C. Steenkamp G.R. Lubbe

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Senior Liaison Officer ...	Mrs E.P. du Plessis, B.Sc. Hons, S.E.D. (Editing and translating)
Senior Agricultural Research Technician ...	Mrs B.A. Momberg*, B.Sc. (Editing)

*Half-day
**Part-time
†Plant Protection Research Insitute

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Book Reviews

TRANSVAAL LOWVELD AND ESCARPMENT including the Kruger National Park, South African Wild Flower Guide 4, by JO ONDERSTALL. *Botanical Society of South Africa, Kirstenbosch, Claremont 7735*. 1984. Pp. 222, 371 colour photographs, 1 map. Price: soft cover, R16,50 + GST; hard cover, R25,00 + GST.

This book, which is also available in Afrikaans, is the fourth in a series of wild flower guidebooks being published by the Botanical Society of South Africa. P. van Wyk points out in the preface, that it is the first in the series to deal with a region outside the Cape Province. The area concerned is enclosed by the borders of Zimbabwe, Mozambique and Swaziland and by the Transvaal Drakensberg escarpment. Both the varied topography and wide range in annual rainfall have endowed the region with a mosaic of different macro- and micro-habitats, and the beauty of the area is, in part, due to the close proximity of some of these.

Other books in this series are: 1, Namaqualand and Clanwilliam (1981) by A. le Roux & E. Schelpe; 2, Outeniqua, Tsitsikamma and eastern Little Karoo (1982) by A. Moriarty; 3, Cape Peninsula (3rd edition, 1983) by M. Kidd. The demand for the Namaqualand book has been so great that a reprint and a second revised and enlarged edition have appeared.

This book was written rather for the layman interested in botany than for the botanical scientist. However, although of little relevance to the practising research worker (field ecologists seeking quick plant identifications by matching plants with pictures excluded) it will none the less delight trained botanists. It is, in my opinion, an essential acquisition for any South African institute or organisation involved with teaching or practising plant taxonomy. It is also ‘a must’ for the botanical bibliophile concerned with good reference works.

The text starts with a short introduction which is followed by a section dealing with the different vegetation types (accompanied by photographs), how they are constituted and where they occur. The body of the text is an enumeration of 330 taxa (4 gymnosperms, 100 monocotyledons and 226 dicotyledons) following the widely used De Dalla Torre and Harms system of plant classification. The species dealt with fall into 73 plant families. The text is presented on the left hand page and family names are occasionally followed by a short family description. Below this are the species names which are occasionally followed by recent synonyms. In keeping with the tone of the book, authorities are not mentioned in the text but they are given in the Index to botanical names. Well known English and Afrikaans common names are cited. Below the species names is a short description mentioning the salient features of the plant, its flowering period and details of the habitat(s) in which it may be found. These descriptions are not written in the harsh, dry, telegraphic manner conventionally used in taxonomic treatments (although vital information is not missing) and are therefore pleasing to read. In the margin to the left of the description may appear line drawings of important characteristics not captured by the photographs, such as habit and leaf and fruit structure. The photographs, which appear on the right hand page, are of excellent quality and where necessary up to two photographs are given to illustrate each species. It is the first time that I have seen published photographs of the rare *Asclepias velutina*. Introduced plants are marked by a symbol in both text and index; the symbol for protected plants is unfortunately given only in the index.

The latter part of the book consists of a glossary accompanied by line drawings, an index to botanical names, an index to common names, a list of protected plant species of the Transvaal, a list of threatened plant species in the Transvaal and a bibliography. The occasional error, including the wrongly illustrated botanical terms bipinnate and tripinnate (see glossary) do not detract seriously from this well presented book. With so much of the Transvaal escarpment under increasing exploitation by silviculture and agriculture, indigenous plant diversity in the region can only decrease. This book could prove a timely and important, if somewhat limited, record of the species richness of the region. This work sets a high standard that will hopefully be followed by others producing similiar works.

A. NICHOLAS

HOTTENTOTS-HOLLAND TO HERMANUS, South African Wild Flower Guide 5, by LEE BURMAN and ANNE BEAN, photography by JOSE BURMAN. *Botanical Society of South Africa, Kirstenbosch, Claremont 7735*. 1985. 219 pages, 194 colour pages. Price: soft cover, R16,50 + GST; hard cover, R25,00 + GST.

The Botanical Society was founded in 1913 to support the National Botanic Gardens and thus to promote the conservation and cultivation of our indigenous flora. One of the many projects of the society is the publication of a series of wild flower guides which it is hoped will eventually cover the local floras of most of the regions of South Africa, especially where there is public demand for such or where there is a conservational or educational need for a book to improve public awareness of the local flora.

With this work, the fifth in the series of guides, the flora of the area between Stellenbosch, Fransch Hoek and Hermanus has been covered. It is an area of mostly rugged unspoilt mountains covered by fynbos vegetation which has the highest species density in the country. It is served by many interesting short to long walks or trails which are becoming very popular among the local inhabitants as well as those from upcountry: the Boland Hiking Trail, hikes in the Jonkershoek area, those on the Paardeberg above Kleinmond and at Betty’s Bay and the Rotary Way and Fernkloof Nature Reserve trails above Hermanus.

The book covers 732 species in full colour, four species to a page with accompanying text on the opposite page. The text is a good, readable and informative botanical text for the casual reader, the interested amateur, and, dare I add, many a botanist who may find himself in the area. The arrangement of species follows that of Engler and Prantl. Common names are given where applicable. There is a very useful introduction covering general aspects of vegetation, geology, fire, conservation and the walks and trails in the area. The text is by Mrs Lee Burman and Mrs Anne Bean, the latter of the Bolus Herbarium, University of Cape Town. The photographs, which are mostly of excellent quality and easily recognizable, are the work of Jose Burman (husband of the senior author) whose name is synonymous with climbing and hiking books in the south-western Cape.

Criticisms of the book are very few. My main worry is about the quality of the binding of the soft cover edition. The production is geared for use in the field, so I have reservations about its lasting powers. The review copy, which has not seen field use but some library use, is coming adrift very badly, caused probably by poor quality glue. Fortunately the book is printed in sections sewn together, not by that abominable process called ‘perfect’ binding, so one can reglue one’s copy. I have doubts about the identity of *Erica longiaristata* (p. 154) which looks more like *E. axilliflora*.

This book is available in English and Afrikaans editions and costs only R16,50, which in today’s economic terms, is dirt cheap. This is made possible by financial support received from the Branch of Forestry of the Department of Environment Affairs, the Department of Nature and Environmental Conservation of the Cape Province, the Endangered Wild Life Trust, the South African Nature Foundation and the Botanical Society itself, to all of whom we owe a sincere vote of thanks for making it available. Thanks also and congratulations to the authors for a fine piece of work. I unreservedly recommend the book to any lover of nature whether he is the active type who gets out into the field or the not-so-lucky one who can enjoy the flora from the colour plates — I shall certainly use my copy.

E. G. H. OLIVER

Gramineae for the FLORA OF TURKEY Volume 9, edited by P. H. DAVIS. *University Press*, Edinburgh. 1985. Pp. 465, 84 maps. Price: R219,00.

AUSTRALIAN GRASS GENERA, ANATOMY, MORPHOLOGY, KEYS AND CLASSIFICATION Second Edition, by L. WATSON and M. J. DALLWITZ. The *Australian National University, Research School of Biological Sciences*, Canberra. 1985. Pp. 165, 48 figures. Price (paperback only): R32,00.

These two grass treatments are reviewed together because each has an unusual approach to identification keys for genera, and because comparisons between them lead to a discussion of objectives for regional floristics in the light of recent methodological developments in taxonomy. The *Flora of Turkey* provides a multi-access formula key to grass genera as an addition to a convention-

ally produced treatment of tribes, genera and species. In contrast, the keys in the *Australian grass genera* appear to be ordinary bracketed keys, but in fact, keys as well as descriptions are computer-generated from a massive database of comparative descriptive information for the grass genera of the world. Thus, the *Flora of Turkey* includes an interesting addition to an otherwise conventional regional flora, while the *Australian grass genera* clothes in traditional garb a revolutionary development for plant taxonomy.

Volume 9 of the *Flora of Turkey* includes Cyperaceae and Juncaceae as well as Gramineae, and is the concluding volume for the *Flora*. The complete work is a success story for a major modern flora. The nine volumes were finished in only 20 years, surely a record time for a work that is comprehensive in coverage, and includes literature, synonymy, type specimens, brief descriptions, taxonomic and ecological notes, altitude, numerous specimen citations arranged in a coarse grid system, distribution maps and extent of distribution. The *Flora* has been well received from the first volume, and previous reviewers have stressed its importance as a guide to the plants of the area, as a compendium of immense amounts of phytogeographical and taxonomic information, and as a summary of what still needs to be investigated.

The treatment of grasses follows the higher classification of Tzvlev (1976), and covers 3 subfamilies, 32 tribes, 142 genera and about 500 species. About eight 'outside' specialists contributed tribes and genera, but many groups were written by the editor or his two research assistants. The authorship of the keys and the family and tribal descriptions is not clear. The usual dichotomous key is indented, and the couplets are generally simple, being rarely longer than a single printed line. The multi-access formula keys to genera are an innovation in the *Flora of Turkey*, and have been previously presented for Umbelliferae (1972, 4: 280) and Compositae (1975, 5: 25).

The addition of multi-access keys as an extra aid to identification in large and difficult families is a response to the fact that dichotomous keys may not fill the needs of all users. Moreover, the formula itself is a first step towards manual retrieval of fully comparative descriptive data. Determining the 'formula' is pedagogically valuable because the user must look carefully at the unknown plant as an entity, rather than merely examine unrelated characters in an arbitrary series, as is the practice in working through dichotomous keys. However, it is somewhat time-consuming to determine the formula and troublesome to read the printed formula correctly. The dichotomous keys can probably be 'run' more quickly.

The *Australian grass genera* is the result of a new approach to data organization for taxonomy. Using the DELTA (**DE**scriptive **L**anguage for **TA**xonomy) computer system, a list of characters for the group under study is established, and descriptive data based on the character list is coded and entered in the computer for each taxon. The computerized data is fully comparative, it can be easily augmented and corrected, and it can be used for a number of purposes: description 'writing', key generation, online identification and information retrieval, computer-aided classification and automatic typesetting. Most important, all the characters used are clearly defined, their occurrence in taxa is easily seen, and the data underlying taxonomic conclusions is available for review.

The descriptions, subfamily classification and keys presented in *Australian grass genera* are based on 332 characters of habit, vegetative morphology, reproductive organization, inflorescence, spikelets, fruit, embryo, seedling, abaxial leaf blade epidermis, transverse section of leaf blade, physiology, culm anatomy, cytology, taxonomic position, distribution and ecology. The printed descriptions, which appear in alphabetical order, are understandably lengthy but the prose style is acceptable (in contrast to the first edition, in which the 'computer origin' of the English was all too apparent). The subfamily and supertribal classification of the genera was derived from the generic data for the world using computer programs for phenetic classification (Watson, Clifford & Dallwitz 1985). A number of bracketed keys are provided: to all Australian genera, divided on character occurrences (220 genera) and divided by subfamily (221), to those of New South Wales (157), the Northern Territory (108), Queensland (169), South Australia (117), Tasmania (46), Victoria (115), Western Australia (150), central Australia (66) and the Australian Capital Territory (71). Although most of the steps in the keys are dichotomous, a few may have as many as four choices. This may be disconcerting because there is no warning to the user in the introduction to the keys.

Comparisons between the *Flora of Turkey* and the *Australian grass genera* lead to some comments on future directions for flora treatments in the age of omega taxonomy and of the computer. The objective of a regional flora is to provide a guide to identification of the plants in an area, and a secondary aim is to provide a compact, comprehensive source of information about the plants. The basic differences between the two treatments considered here are, firstly, the time scale over which the treatment may be valid, and secondly, the relation between the descriptive data and the descriptions and keys derived from it.

The *Flora of Turkey* is completed. Drafts were no doubt written and typed, and the pages (of the later volumes at least) were produced for the printer by an IBM composer. But what of the future? Any additions of taxa, new understanding of characters, improvements in classification or alterations in nomenclature cannot be taken up in an overall coverage of the Turkish flora. A new edition incorporating changes would have to be re-done as a separate exercise, even if based on the present treatment. The descriptive data presented is the minimum required for identification, and, except for the character states selected for the multi-access key, the characters in the descriptions and keys are not necessarily comparative throughout the treatment of all the genera.

In contrast, the study of Australian grass genera is not completed. The computerized descriptive data underlying the treatment exists as a growing resource independent of the publications derived from it. Additions and changes to the descriptive data can be made frequently, and more accurate descriptions, keys and camera-ready copy for printers can be generated for different levels of treatment and specific formats needed for particular purposes. Finally, a completely new identification aid is available: 'online' identification can be done through the computer, so that characters apparent on a particular specimen can be used, in any order convenient.

Plant classification now increasingly uses characters from a variety of disciplines and often emphasizes the adaptive value of certain characters. Yet the need still remains for efficient sources of plant identification and information, which in order to be generally useful must rely on morphological characters. Until now, this need has largely been met by regional floras. The DELTA computer system can act as a bridge between the accumulation of comprehensive descriptive information needed for classification, and the time-honoured descriptions and keys presented in regional floras for more than 150 years. The same continuously augmented data can be used both to develop classifications and to generate taxonomic treatments to a desired format. Thus the flora treatment of the future can be based on a broader data set than is suitable for publication, and revised editions can be prepared with a minimum of effort.

G. E. GIBBS RUSSELL

THE MORAEAS OF SOUTHERN AFRICA, by PETER GOLDBLATT with watercolours by FAY ANDERSON. *Annals of Kirstenbosch Botanic Gardens* Vol. 14. 1986. Pp. 224, 66 colour plates and numerous black and white drawings, 104 distribution maps. Price: R45,00 + GST.

The genus *Moraea* currently comprises 119 species which are confined to subSaharan Africa, with the main concentration of species in the winter rainfall region of southern Africa. *Moraea*, together with *Homeria* and several minor genera, is placed in the subtribe Homeriinae of the tribe Irideae.

The small genus *Dietes*, which has often been included in *Moraea* in the past, and which occurs in forest habitats, is thought to be close to lines which gave rise to *Moraea*, a genus of specialized habitats experiencing seasonal periods of drought.

Peter Goldblatt, the acknowledged specialist on southern African Irideae, published revisions of the southern African *Moraea* taxa in 1973 and 1976. Since then continuing field- and cytological investigation has brought to light a number of new species and led to the re-instatement of formerly included taxa; no fewer than four new species are published in the present volume. In addition Goldblatt's biosystematic and cytological investigation of *Homeria* (published in 1981) led to the transfer of three species to *Moraea*. The similarities in floral morphology to *Homeria* are thought

to be the result of convergent evolution. These three species are easily identifiable due to their blue or purple flowers, whereas those of *Homeria* are always yellow, pink or orange, or sometimes white.

The present volume is a much needed synopsis of the southern African species and as such will be very useful to botanists. Much more than that, the beautiful colour plates by Fay Anderson cannot fail to awaken the layman's interest in the genus. Of the 103 species treated, 70 plus two subspecies are illustrated in full colour, and the remainder in black and white. One can only marvel at the tremendous variation in floral morphology. Most species are brightly coloured, some have large flowers, and many would make worthwhile horticultural subjects. Despite this they are at present seldom cultivated in southern Africa although some species are widely grown in Europe. The dust jacket of the volume bears an illustration of one of the peacock moraeas, *M. loubseri* Goldbl., probably the most striking of all the species. Sadly, some species mainly from the winter rainfall region, including *M. loubseri,* are very localized in distribution and are threatened with extinction due to human activity. One species, *M. incurva* G. J. Lewis, is thought to be already extinct. Fortunately, due to timely action by conservationists, many of these threatened species are maintained in cultivation.

This volume is the first publication in the new series, *Annals of Kirstenbosch Botanic Gardens,* which replaces the previous *Journal of South African Botany* supplementary volumes. The numbering sequence however, is continued. In this volume the author includes sections on the history of the genus; morphology; floral biology and pollination; conservation; cultivation (general comments); distribution and evolution; subgeneric classification; relationships and systematic position of the genus; a systematic treatment of the 103 southern African species, including a key to the species, full descriptions, illustrations, distribution maps, and also specific notes on cultivation where appropriate, for each species; and a bibliography.

A few minor errors and blemishes were noted. The 103 species treated include two from Zimbabwe, which falls outside the *Flora of southern Africa* area. Table 1 (p. 12 & 13) is an enumeration of the subgenera, sections and species. It is nowhere referred to in the text or the table of contents. More seriously, the new species are *not* indicated with an asterisk as stated in the caption, and the sections are either numbered incorrectly or not at all. In the key to the summer rainfall species (pp. 24–26) the species numbers do not correspond to those in the text. On page 27 is an uncaptioned colour plate, which is nowhere referred to in the text, but is clearly *M. fugax* (Delaroche) Jacq. subsp. *fugax,* figured once again on p. 99. *Moraea* is misspelled *Morea* on p. 72. An index to the illustrations would be very useful, particularly because, due to space problems, the colour plate is not always opposite the species description, and often two small species are figured on the same plate.

These errors and shortcomings, however, do not detract from the scientific value and beautiful presentation of the publication. It is a volume worth having.

C. REID

GENERA GRAMINUM — GRASSES OF THE WORLD, by W. D. CLAYTON and S. A. RENVOIZE. *Kew Bulletin Additional Series XIII. Her Majesty's Stationery Office, London.* 1986. Pp. 389, 24 figures. No price quoted.

The preparation of a complete new coverage of the world's genera of Poaceae, taking into account the vast increase of knowledge in the many fields which have been investigated, particularly during the past three decades, is a daunting task of great complexity. Prerequisites for the successful completion of such an ambitious undertaking are great dedication to the project, the availability of extensive and world-wide collections, superior library services and, preferably, a long tradition in grass research. These conditions were met to a remarkable degree at the Herbarium of the Royal Botanic Gardens in Kew, London, England, where this important new account of the genera of grasses was prepared. The extensive world-wide collections of grasses in Kew are probably unmatched anywhere else, the Kew library is magnificent and Clayton and Renvoize have continued in the footsteps of two great masters in grass taxonomy, namely Otto Stapf and Charles E. Hubbard. A recipe for success was therefore available. It is to the credit of the authors that after jointly devoting nearly 50 years of research to the project, they have brought the task to finality. This generic revision will probably be the last to be attempted in the traditional style and is the first complete reworking of the Poaceae since Bentham & Hooker's treatment in the *Genera plantarum* of 1883 and Hackel's treatment in Engler & Prantl's *Natürliche Pflanzenfamilien* of 1887.

Part one of the *Genera graminum* deals very succinctly with 'the grass plant' under the headings morphology, reproduction, anatomy and metabolism (with special reference to the C_3 and C_4 metabolic pathways and the anatomical structure of the leaf-blades), classification, grasslands, evolution and finally, a descriptive treatment. Part two consists of an enumeration of the genera. A key to the tribes is supplied, followed by subchapters dealing with the six subfamilies Bambusoideae, Pooideae, Centothecoideae, Arundinoideae, Chloridoideae and Panicoideae. Under each subfamily the tribes are arranged according to putative relationships and each tribe is supplied with a key to the genera. The genera are arranged in subtribes. This three-level system is convenient and in most cases proves to be sufficiently flexible to reflect broad relationships. A useful synopsis of the overall scheme is supplied in a separate table. The authors recognize 651 genera and the total number of species of grasses world-wide is indicated as about 10 000. Southern Africa with about 1 000 species, therefore, has 10% of the world's grasses, which agrees with the approximate 10% of the world flora, for the southern African flora as a whole. The Poaceae are undoubtedly the most important of all plant families, particularly as a source of food for man and his domestic animals. The great surge of cytogenetic, anatomical, physiological and ecological research on the Poaceae that has occurred during the last few decades, is therefore understandable. Our understanding of the taxonomy of the grasses has greatly increased as a result, but the full interpretation of the vast amount of accumulated knowledge derived from the many other fields of botany which could lead to a deep understanding of the relationships between subfamilies, tribes, subtribes and genera, has still to be achieved. Clayton and Renvoize's work was therefore eagerly awaited.

The success or otherwise of the present work, has to be judged according to the degree in which the present authors have managed to achieve a convincing new synthesis. It is clear that they have considered and acted on the new information available, and that they have personally gathered anatomical information where this was not available. The research was done over more than two decades and it is evident that, at the start of this period, computers were not yet available, precluding their use, for practical reasons, also at a later stage. The information therefore had to be analysed and presented in the traditional manner. The analysis of vast amounts of data of great complexity is obviously extremely difficult without the use of modern aids. This may explain why the text is often extremely brief and provides few or no reasons even for decisions which affect the taxonomy and nomenclature of important genera drastically.

Before looking at the treatment of particular genera, the principles applied by the authors of this book when interpreting generic limits, need some comment. For the last few decades the tendency has been to define genera as groupings of species which represent, as far as possible, taxa with uniform characteristics. This has resulted in the creation of many more and smaller genera and even of monotypic genera. Many of these genera differ only in minor characters from related ones. In the present work the modern trend to 'purify' genera has in some cases been followed, but in others, somewhat dissimilar entities, formerly separated, have been united. The occurrence of intermediate species, with characters linking two genera, has apparently weighed heavily with the authors in favour of uniting such genera, even where this procedure brings together two or more fairly distinct, although obviously related sets of taxa into a single genus. It is arguable which of the two approaches, 'lumping' or 'splitting', produces the most satisfactory classification, namely the one which most clearly reflects relationships. 'Splitting' the groups has the complication that the 'linking' species often has to be rather arbitrarily placed in one of the 'splits'.

A well known example of the latter is found in the genera *Pennisetum* and *Cenchrus,* linked by the intermediate species *Cenchrus (Pennisetum) ciliaris,* but which are here recognized as distinct genera. A contrasting example is the genus *Diandrochloa,* a split from *Eragrostis* (very easily recognized in most cases but linked by a single somewhat intermediate species), which in this work is sunk into *Eragrostis.* In addition, the genus *Stiburus* con-

sisting of two closely related and easily recognized species, is sunk into *Eragrostis,* further expanding the limits of this already extremely variable genus. In South Africa, the home range of *Stiburus,* few supporters of such excessive 'lumping' will be found. In the decisions on *Diandrochloa* and *Stiburus* the authors have the support of Phillips, whose work is referred to later in this review. *Diplachne* is sunk into *Leptochloa* but at the same time it was found necessary to create two sections, Sect. *Leptochloa* and Sect. *Diplachne,* under *Leptochloa.* This raises the question whether the sinking of *Diplachne* was really necessary, particularly in the light of Phillips's studies in *Kew Bulletin* which led her to maintain *Diplachne.* The three genera *Lasiochloa, Plagiochloa* and *Urochlaena,* endemic in southern Africa, obviously are closely related. Combining the first two into a single genus may have been desirable, but the adoption of an older name, without apparently even considering to conserve one of the existing names, is hardly conducive to stability in nomenclature. The fact that these genera are endemic in a limited geographic area, may have made it easier for the authors to reach such a decision.

The radical changes made by Clayton and Renvoize in the nomenclature of the *Danthonia/Rytidosperma (Merxmuellera)* complex of genera has had far-reaching effects; yet there is no good reason to believe that greater taxonomic stability has now been achieved in this complex and such drastic action seems somewhat premature. Southern Africa has seen about 30% of its grass names change in the last three decades and many of these changes will not stand the test of time. It is not conceivable that taxonomic progress can be stifled by practical considerations. Taxonomy nevertheless has practical implications and sufficient restraint should be practised when making nomenclatural decisions to ensure that it does not hamper what it sets out to achieve, namely the creation of a stable and useful system of classification. Other examples were noted of what appear to be arbitrary decisions, apparently not backed up sufficiently by sound facts and arguments. The relevant literature references, especially those dealing with genera, often proved difficult to trace. Phillips's study of generic concepts in the Eragrostideae in *Kew Bulletin* 37: 133–162 (1982) does not appear under the genera or in the 'References', but was found as a main reference under the tribe Eragrostideae. It is clear that this arrangement was adopted to reduce repetitious referencing but it is debatable whether this space-saving is justified.

In spite of the reservations expressed, the authors have in the *Genera graminum* brought together a vast amount of information and successfully summarized progress made during the last decades in grass taxonomy. All agrostologists are in their debt. In the light of the strongly traditional, and not entirely consistent approach followed, a 'modern' synthesis of the generic classification of the grasses has, in my opinion, not been fully achieved. This is most likely what the authors themselves meant to convey when they advised the reader that: ' . . . there is something here to annoy everyone, so do not bother to chastise — think rather to improve.' We await a definitive treatment of grass genera in the future.

B. DE WINTER

MYCOTOXICOLOGY: INTRODUCTION TO THE MYCOLOGY, PLANT PATHOLOGY, CHEMISTRY, TOXICOLOGY, AND PATHOLOGY OF NATURALLY OCCURRING MYCOTOXICOSES IN ANIMALS AND MAN, by W. F. O. MARASAS and P. E. NELSON. *The Pennsylvania State University Press.* 1987. Pp. 102. Price: $34,50.

The authors have selected eleven mycotoxicoses and discussed the mycology and plant pathology of the toxigenic fungi, the clinical signs, pathology and epidemiology of the mycotoxicosis, the chemistry and toxicology of the mycotoxins, and methods to control the mycotoxicosis. An additional section discusses prospects for future research and control. The publication is illustrated with 48 colour plates, six black-and-white plates and 10 figures, nine of which show the chemical structures of the different toxins. Over 200 references are included in the reference list. The index is usefully divided into the following subject listings: causative fungi, hosts, mycotoxicoses, mycotoxins and species affected.

This is a concise account of mycotoxicology. It stresses the importance of an interdisciplinary approach by mycologists, plant pathologists, and medical and veterinary scientists to the subject. In South Africa it will be particularly useful to undergraduate students in these fields and in food science, with selected mycotoxicoses being prescribed as topics for discussion in seminars and tutorials. With this textbook now available, more teachers might be inclined to include mycotoxicology in their courses. Teachers intending it for classroom use should also invest in the set of 48 colour slides (not 72 as given on the dust cover) which are available from the publisher at $100.

P. S. KNOX-DAVIES

Perskor

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CONTENTS – INHOUD

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